Inertia in the Fed's Monetary Policy Rule

Gregory R. Duffee

This version: August 17, 2026
First version: October 2025

Abstract

Using data from futures on short-term interest rates, I document a sharp change in expected inertia in the Federal Reserve's monetary policy rule. Prior to 1992, markets anticipate only modest inertia. Beginning in 1992 and continuing thereafter, markets anticipate much more inertia. This change in expectations predates, and to some extent causes, an increase in inertia in the Fed's actual monetary policy rule. In early 1994 Chairman Greenspan pushed for operating procedures that better avoid surprising markets. One change was greater transparency. The other was high inertia, because markets anticipated it. Both investors' expectations of high inertia and the Fed's policy change were grounded in the experience of the 1990–1991 recession and its aftermath.

Affiliation: Johns Hopkins University. Contact information: voice 410-516-8828, email duffee@jhu.edu. Thanks to seminar participants at the Federal Reserve Board, conference participants at the 13th Annual Asset Pricing Workshop at the Banque de France, Larry Ball, Michael Bauer, Jonathan Wright, and especially Ed Nelson for valuable comments.

An established literature documents substantial inertia, also described as gradualism or partial adjustment, in the Federal Reserve's policy rule. Researchers explore rules inspired by Taylor (1993), augmented with one or more lags of the policy rate. One example is

$$i_t = (1-\rho)[c + \phi_g E_t(gap_{t+k_g}) + \phi_\pi E_t(\pi_{t+k_\pi})] + \rho i_{t-1} + e_t. \tag{1}$$

The time-t target, in square brackets, depends on forecasts of the k_g-ahead output gap and k_π-ahead inflation. The policy rate moves toward the target at a rate determined by the inertial coefficient ρ.

The magnitude of inertia matters both to macroeconomics and finance. As suggested by Goodfriend (1991) and formalized by Woodford (2003), high inertia magnifies the business-cycle effects of innovations in the policy rate. Households and firms respond to anticipated cumulative changes rather than simply the initial change. Similarly, the dynamics of the short rate, and thus the dynamics of the entire term structure, depend on how gradually the Federal Reserve responds to macroeconomic information.

In an influential article, Clarida, Galí, and Gertler (2000) estimate variants of (1) to explain the Federal funds rate. They report that for the sample 1960 through 1996, "...only between 10 and 30 percent of a change in the interest rate target is reflected in the Funds rate within a quarter of the change."(pp. 157-158) Subsequent research using various techniques arrives at the same conclusion, including Coibion and Gorodnichenko (2012) and Carvalho, Nechio, and Tristão (2021). Coibion and Gorodnichenko (2012) observe "...much of the recent macroeconomics literature has simply assumed interest-rate smoothing on the part of central bankers ..."(p. 128).

However, omitted variables contaminate these estimates of inertia. Parsimonious policy rules exclude an array of real-world complexities. As former Federal Reserve Governor Lindsey said, "...we look at a whole raft of variables—we ignore nothing and focus on nothing."[1] Rudebusch (2002, 2006) draws on a well-known result from econometrics, pointing out that the lagged rate in (1) picks up these omitted variables. Typical methods of estimating policy rules cannot disentangle the effects of persistent omitted variables from true inertia.

Instead of estimating directly a policy rule, I use innovations in the term structure of interest rates to draw inferences about the market's perception of policy inertia. Two con-

[1]Quoted in Bradsher (1994).

siderations motivate this choice. First, examining innovations rather than levels circumvents the omitted variable problem. Second, using expectations impounded in the term structure rather than realizations of future policy rates converts dynamic equations such as (1) into contemporaneous equations, leading to more statistical power.

The evidence reveals a sharp shift in market expectations of inertia in the early 1990s. Comovements among short-term interest rates implied by futures prices provide the clearest picture. I estimate regressions of daily changes in Eurodollar futures rates on contemporaneous changes in a near-term Fed funds futures rate. Kuttner (2001) estimates similar regressions, using a sample of Federal Open Market Committee (FOMC) meeting dates to study monetary policy surprises. I use samples of only non-meeting dates to study the policy rule. The coefficients across the term structure of futures rates indicate how market participants anticipate the Fed will react over time to the news on a given day.

Panel A of Figure 1 displays estimated coefficients for each of the years 1989 (when Fed funds futures data are first available on Bloomberg) through 1991. Panel B displays estimates for the individual calendar years 1992 and 1993, as well as the multi-year samples 1994 to 2008 and 2016 through 2019. The data sample ends just prior to the pandemic and excludes the zero-lower-bound period of 2009 through 2015. Standard errors, not displayed, range from 0.05 to 0.19.

For each year from 1989 through 1991, the estimates imply that investors anticipate modest short-run policy inertia. Panel A shows that for these years, the cumulative expected change in short rates peaks somewhere between three and eight months ahead, at roughly 1.5 times the initial change. The cumulative expected change then declines as the horizon increases, such that two-year-ahead Eurodollar futures rates move approximately one-to-one with the expected initial change.

The contrast between Panels A and B reveals the remarkable shift. Beginning in 1992, markets anticipate that an innovation in the funds rate will be followed by steady changes in the funds rate in the same direction for many months. Point estimates vary widely across different post-1991 sample periods, but all the samples exhibit much more anticipated inertia than do those examined in Panel A. For example, estimates of the cumulative expected change at the two-year horizon across different samples range from about 1.6 to 2.5 times the expected initial change.

Regressions using futures on the Secured Overnight Financing Rate (SOFR) produce

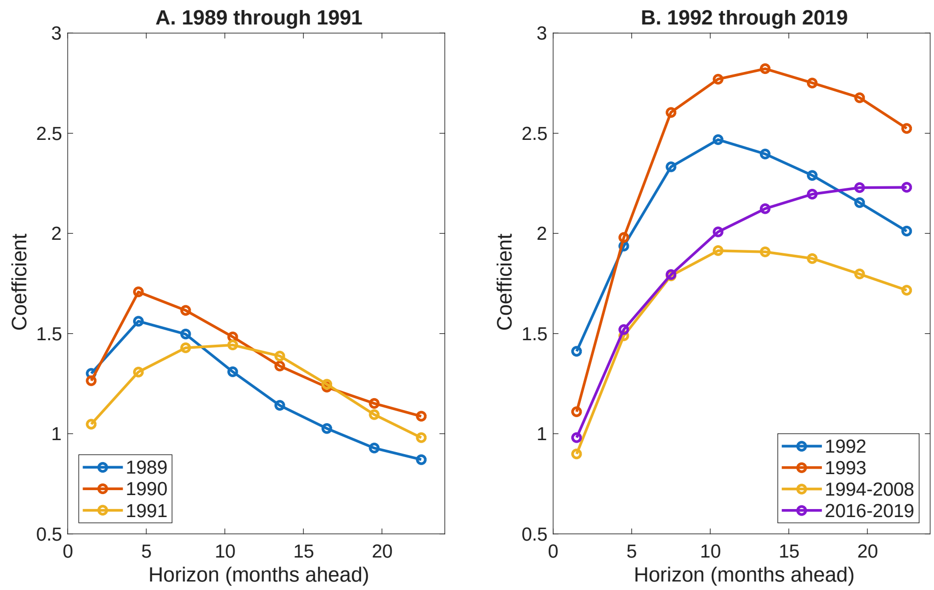

Figure 1. Regressions of changes in Eurodollar futures rates on the contemporaneous change in a near-term Fed funds futures rate, for non-FOMC meeting days. Dependent variables are daily changes of rates implied by Eurodollar futures prices for the first 8 quarterly contracts. The explanatory variable is the change in the rate implied by the Fed funds futures price for the contract month that begins after the next FOMC meeting date. Regressions are estimated separately for the sample periods indicated in the figure.

similar results for the post-pandemic sample of 2022 through 2025. Additional results at both the daily frequency (nonfarm payroll surprises) and FOMC-meeting frequency (Greenbook/Tealbook forecast revisions) explicitly link the patterns in Figure 1 to macroeconomic news.

The policy rule (1) implies that the effects of macroeconomic news on the expected path of future short rates depend on the persistence of the macroeconomic state variables as well as inertia. Thus, as conditional persistence and/or conditional inertia vary, conditional regression coefficients will also vary. I show that the conditional term structure responses to news are closely tied to expected growth in the output gap, as well as market perceptions of the Fed's responsiveness to output and inflation, as estimated by Bauer, Pflueger, and Sunderam (2024a). The magnification of near-term future rates increases at times when expectations of economic growth are high, the perceived sensitivity to output is high, and the perceived sensitivity to inflation is low. This evidence suggests investors anticipate greater inertia during tightening cycles and when the Fed's policy rule is more closely tied to output than inflation.

In a broad sense, these regressions summarize aspects of forward rate comovement (equivalently, yield comovement) across a part of the term structure. Such comovement has long played a central role in term structure modeling beginning with Litterman and Scheinkman (1991). Yet although many decades of Treasury bill and bond yields are available, I find that the patterns here are apparent only when using data from futures markets. Relative to the bulk of the term structure literature, my analysis focuses on high-frequency changes of short-maturity forward rates. Cash-market Treasury bill yields contain liquidity and other transitory components that hopelessly contaminate daily-frequency changes, obscuring the patterns visible using futures prices.

Why did market perceptions of inertia change beginning in 1992? I argue the shift is driven by the recession of 1990–1991 and its aftermath. An eyeball test strongly suggests that the Fed follows a highly inertial strategy during this easing cycle. The funds rate declines from 8.25% at the beginning of 1990 to 3% at the end of 1992, in fifteen 25 b.p. increments and three 50 b.p. increments. By the end of 1991 market observers believe the Fed's policy rule includes substantial inertia. Chairman Greenspan seemingly confirms the eyeball test. His congressional testimony in early 1993 refers to the "purposely gradual" easing actions through 1992.[2]

However, transcripts of FOMC meetings from 1990 through 1992 make clear that the Fed did not follow an inertial rule during this period. Inertia produces predictable changes in the same direction. Notwithstanding Greenspan's postmortem testimony, transcripts reveal that the positive serial correlation in changes was unplanned. The Committee cut the funds rate in repeated small increments because members of the Committee, and in particular Greenspan, are repeatedly surprised by the recession of 1990–1991 and the continued economic weakness into late 1992.

Instead, the Fed begins to follow a highly inertial strategy at the beginning of 1994, at the same time and for the same reason that it begins the transition to greater monetary policy transparency. Again, the shift is driven by the recession of 1990–1991 and its aftermath. Based on this experience, Greenspan recognizes the importance of conducting monetary

[2]Greenspan (1993), p. 7.

policy in a way that does not surprise markets. In particular, he concludes that the large cumulative decline in the funds rate from 1990 through 1992 did not trigger higher inflation expectations because the Fed did not surprise markets with aggressive easing.

He also concludes that the recession and weak recovery were driven by the slow deleveraging of firms and households. Leverage became unsustainably high owing to heavy debt financing, coupled with sudden declines in the market values of previously overpriced assets. Thus by the end of the easing cycle in late 1992, he places heavy emphasis on the predictability of policy. Unexpected tightening can trigger asset-market losses, while unexpected easing can weaken the market's confidence in the Fed's commitment to low inflation.

Greenspan puts this strategy of predictability into action at the February 1994 FOMC meeting. In his words, he "went berserk" at the meeting, pleading with the other FOMC members to begin a tightening cycle by initially raising the funds rate only 25 b.p. rather than 50 b.p.[3] At the same meeting he asked that the FOMC publicly announce its decision. Thus the Fed's decision to follow a highly inertial strategy is, in some sense, accidental. The Fed prefers to avoid surprising the market and the market expects the Fed to follow an inertial strategy.

My research builds on previous contributions. Coibion and Gorodnichenko (2012) introduce the use of innovations in estimation of inertial policy rules to avoid the omitted variable problem. Rudebusch (2002) first recognizes that information in the term structure helps us draw inferences about the market's expectation of inertia. I discuss their approaches in detail below. The econometric approach here connects most closely with Hamilton, Pruitt, and Borger (2011). They use daily changes in Fed funds futures rates and macroeconomic announcement surprises to study monetary policy rules. Using data samples that begin in 1994, they document substantial evidence of policy inertia. They do not examine prior data.

Another literature mines the transcripts of FOMC meetings and speeches of FOMC members to study policy rules. Using documents dated 1994 and later, Sardoni and Wray (2006) and Coibion and Gorodnichenko (2012) find strong evidence that the FOMC follows an inertial strategy. Other research studies perceptions of monetary policy. Kim and Pruitt (2017) and Bauer, Pflueger, and Sunderam (2024a,b) use Blue Chip forecasts to infer forecasters'

[3]He uses this phrase at the May 2004 FOMC meeting to describe his remarks at the February 1994 meeting. Board of Governors of the Federal Reserve System (2004), p. 86.

beliefs about the policy rule. Bocola, Dovis, Jørgensen, and Kirpalani (2024, 2025) use daily observations of long-term nominal and inflation-indexed bonds to infer policy stances on inflation stabilization.

Section 1 motivates my econometric approach. Section 2 describes the data. Section 3 presents the empirical results. Section 4 links the shift in inertia during the early 1990s to the lessons of the 1990–1992 economic downturn. Section 5 discusses weaknesses in typical methods to infer the magnitude of inertia in the Fed's policy rule. Section 6 concludes.

1 Econometric Motivation

This section uses a stylized description of the central bank's monetary policy rule to motivate the empirical analysis that follows. It is a statistical model designed to describe an equilibrium rather than a fundamental model that motivates an equilibrium. The empirical analysis does not attempt to uncover structural coefficients, thus an equilibrium model does not offer any advantages.

1.1 A multifactor policy framework

The target policy rate depends on current economic conditions and longer-term trends, which I label collectively as factors. These factors can include the output gap, output growth, inflation, financial conditions, and trends in the central bank's long-run inflation target and long-run real rates. They can also include perspectives of the members of the FOMC committee, leaning dovish or hawkish.

The N-vector x_t captures these components. For simplicity, the factors follow mean-zero independent autoregressive processes with time-invariant dynamics. Denote their autocorrelations as

$$\mathrm{Cor}(x_{n,t}, x_{n,t-k}) \equiv \delta_{n,k}, \quad n = 1, \ldots, N. \tag{2}$$

These autocorrelations appear in the analysis that follows, thus I introduce notation to keep track of the vector of autocorrelations through lag k:

$$\Upsilon_{n,k} \equiv (\delta_{n,0}\ \delta_{n,1}\ \ldots\ \delta_{n,k})'\,. \tag{3}$$

Factor news arrives at each date. This news consists of contemporaneous innovations to the factors. Innovations are i.i.d.,

$$x_{n,t} - E_{t-1}x_{n,t} = \eta_{n,t}, \quad E(\eta_{n_1,t}\eta_{n_2,t}) = 0 \ \forall \ n_1 \neq n_2, \quad \text{Var}_{t-1}(\eta_{n,t}) = \sigma_n^2. \tag{4}$$

The factors drive the FOMC's target policy rate. Ignoring a constant term, the policy target rate is linear in the factors with factor-specific loadings

$$i_t^* = \sum_{n=1}^{N} \phi_n x_{n,t}. \tag{5}$$

The relation between the target rate and the actual policy rate accommodates inertia parameterized by the coefficient ρ. Again ignoring a constant term, the policy rate is

$$i_t = (1-\rho)i_t^* + \rho i_{t-1}, \tag{6}$$

or equivalently

$$i_t = (1-\rho)\sum_{k=0}^{\infty} \rho^k i_{t-k}^*. \tag{7}$$

Unlike Equation (1), (6) and (7) do not include error terms, often described as monetary policy shocks. In some sense their absence is only about labeling. Policy shocks can be included in the functional form for the target rate. However, including them in the target rate imposes the restriction that monetary policy shocks are also subject to inertia as parameterized in (7). Section 3.2 presents some evidence about inertia associated with monetary policy shocks.

Before getting into detailed implications of this framework, it is worth mentioning a missing feature that can complicate some econometric methods to infer inertia. The setting rules out news about future target rates that does not affect the current target rate. To illustrate this missing news, consider a simple policy rule that sets the target rate as a function of expected inflation one quarter ahead,

$$i_t^* = \phi_\pi E_t(\pi_{t+1}).$$

In the context of this section's factor model, the factor is

$$x_t = E_t(\pi_{t+1}).$$

The tight assumption on factor news given by (4) rules out the possibility that news arrives at t about x_{t+1} that is not embedded in news about x_t. Interpreting the factor as expected inflation, agents do not learn anything about inflation at more distant horizons independently from what they learn about next period's inflation.

A richer setting allows for independent sources of news about different forecast horizons. For example, we could write one-quarter-ahead expected inflation as

$$x_t = \delta x_{t-1} + \eta_{1,t} + \eta_{2,t-1}.$$

The news $\eta_{2,t-1}$ is observed at $t-1$. In other words, agents learn at $t-2$ information about time t's one-quarter-ahead forecast of inflation.

Such news affects the term structure of yields at $t-1$ as investors price it into bonds. In practice, this type of news plays an important role in term structure behavior. Researchers developed multifactor term structure models in part to capture news about future short-term rates that is embedded in longer-term yields but not in the current short rate.[4] The next subsection discusses why this type of news can affect some methods for inferring inertia.

Returning to the original framework, use straightforward algebra to write the policy rate as an infinite sum of current and past scaled innovations

$$i_t = (1-\rho)\sum_{n=1}^{N}\phi_n\sum_{k=0}^{\infty} f(k;\rho,\Upsilon_{n,k})\eta_{n,t-k}, \tag{8}$$

with the scaling function defined recursively as

$$\begin{aligned} f(0;\rho,\Upsilon_{n,0}) &\equiv \delta_0; \\ f(k;\rho,\Upsilon_{n,k}) &\equiv \delta_k + \rho f(k-1;\rho,\Upsilon_{n,k-1}). \end{aligned} \tag{9}$$

The scaling function plays an important role in what follows. For concreteness, consider a

[4] For a textbook treatment of these models see, e.g., Singleton (2006).

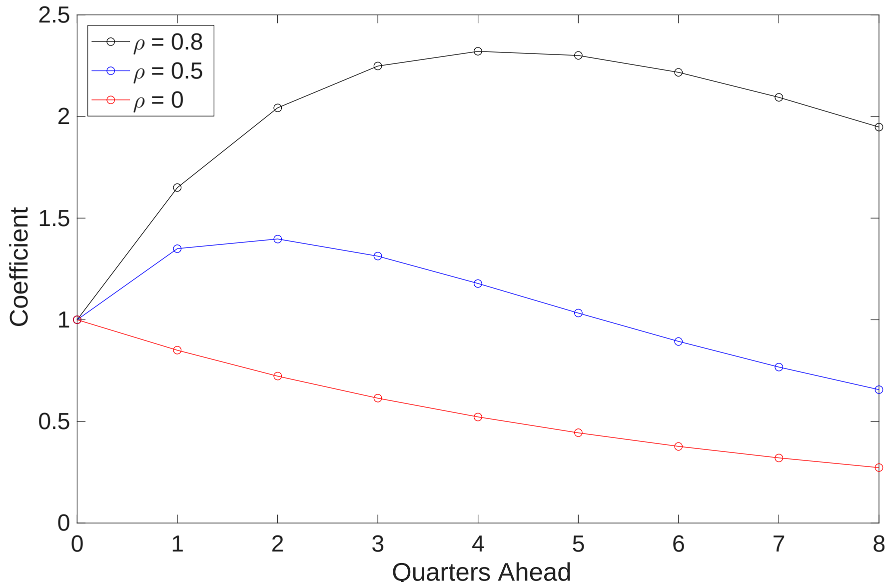

Figure 2. Model-implied sensitivity of the k-ahead policy rate to a target-rate innovation. The model's monetary policy rule exhibits inertia with inertial parameter ρ. The target rate follows an AR(1) process with persistence parameter $\delta = 0.85$, where time is measured in quarters. The contemporaneous sensitivity is normalized to one.

unit innovation at t to factor n. By definition, the contemporaneous, one-period-ahead, and two-period-ahead responses are proportional to $f(0; \rho, \Upsilon_{n,0})$, $f(1; \rho, \Upsilon_{n,1})$, and $f(2; \rho, \Upsilon_{n,2})$ respectively. These three function values are

$$f(0; \rho, \Upsilon_{n,0}) = \delta_{n,0} = 1, \quad f(1; \rho, \Upsilon_{n,1}) = \delta_{n,1} + \rho, \quad f(2; \rho, \Upsilon_{n,2}) = \delta_{n,2} + \delta_{n,1}\rho + \rho^2. \quad (10)$$

The first terms of each function value in (10) are the direct effects of the innovation at t on the factor at $t + k$, $k = 0, 1, 2$. The autocorrelations determine the speed at which the direct effect dies out over time. In the absence of inertia, there are no other terms. Inertia adds a term at k equal to the inertial coefficient times the scaling function value at $(k - 1)$. The special case in which the autocorrelations are those for an AR(1) process provides a little more intuition. With an AR(1) persistence parameter δ, the scaling factor function simplifies to

$$\text{AR(1) special case:} \qquad f(k; \rho, \delta) \equiv \begin{cases} \frac{\rho^{k+1} - \delta^{k+1}}{\rho - \delta}, & \rho \neq \delta; \\ (k+1)\delta^k, & \rho = \delta. \end{cases} \quad (11)$$

Figure 2 plots the scaling function for three choices of ρ and autocorrelations of an AR(1) process with persistence parameter $\delta = 0.85$. Interpreting a period as one quarter, this persistence corresponds a business-cycle frequency, with a half-life of a little more than four quarters. The value $\rho = 0.8$ is close to the estimates using quarterly data produced by Clarida et al. (2000) and Coibion and Gorodnichenko (2012). For this value, the scaling function peaks at four quarters ahead. In other words, the maximum effect on the policy rate of an innovation to the target rate is reached a year after the innovation is realized. The value $\rho = 0.5$ has a maximum effect at about two quarters. When inertia is zero, the contemporaneous response is larger than any expected future response.

1.2 Exploiting the information in innovations

From (8), the innovation in the j-ahead expected policy rate is

$$(E_t - E_{t-1})\, i_{t+j} = (1-\rho) \sum_{n=1}^{N} \phi_n f(j; \rho, \Upsilon_{n,j}) \eta_{n,t}. \tag{12}$$

This subsection considers empirical implementations of (12) that require observations of some of the news on either the left or right sides.

1.2.1 Observed innovations in expected policy rates

Assume we observe innovations to both the period-t policy rate and the expected j-ahead policy rate. Regress the latter on the former,

$$(E_t - E_{t-1})\, i_{t+j} = b_j \,(E_t - E_{t-1})\, i_t + e_{j,t}. \tag{13}$$

Using (12), the regression coefficient is

$$b_j = \sum_{n=1}^{N} \left(\frac{\phi_n^2 \sigma_n^2}{\sum_{k=1}^{N} \phi_k^2 \sigma_k^2} \right) f(j; \rho, \Upsilon_{n,j}). \tag{14}$$

Equation (14) shows that the regression coefficient is a weighted average of the scaling functions (9) for the N factors driving the target policy rate. These scaling functions differ only through the factors' autocorrelations. If the factors all have roughly business-cycle persistence, then a weighted average of their scaling functions looks like the scaling factors in Figure 2.

Equation (14) also shows that regressions such as (13) cannot identify the inertial coefficient. The regression coefficients also depend on the volatilities and autocorrelations of all the factors affecting the policy rate. Instead, a set of regression estimates for different horizons j provides a credibility test for high inertia. For example, coefficients that steadily rise with the forecast horizon for a year or so are consistent with the high-inertia plot in Figure 2. Coefficients that rise with the forecast horizon for three to six months are consistent with the low-inertia plot, while coefficients that decline with the forecast horizon are consistent with minimal or no inertia.

Following a literature beginning with Kuttner (2001) and Gürkaynak, Sack, and Swanson (2005), I use high-frequency changes in fixed-income futures prices in place of the expectation innovations of (13). In other words, I use equivalent-martingale innovations rather than physical-measure innovations,

$$\left(E_t^Q - E_{t-1}^Q\right) i_{t+j} = b_j \left(E_t^Q - E_{t-1}^Q\right) i_t + e_{j,t}. \tag{15}$$

Section 3.2 implements this type of regression.

The first use of term structure information to test for high inertia appears in Rudebusch (2002). Contrasting his methodology with mine helps explain why I adopt this approach. Rudebusch recognizes that when monetary policy is highly inertial, there will be times when market participants anticipate substantial future changes in the policy rate. These anticipated changes will be impounded into the slope of the term structure. He concludes informally that high inertia corresponds to substantial predictability (high R^2s) of forecasting regressions

$$i_{t+m} - i_{t+n} = b_0 + b_1 S_{m,n,t} + e_{m,n,t},$$

where $S_{m,n,t}$ is the slope of the term structure at t from horizon n to horizon m. For the sample 1988 through 2000 he finds little predictability at horizons beyond a few months ahead, and therefore concludes there is little inertia in monetary policy.

However, high predictability is neither a necessary nor sufficient condition for high inertia. The voluminous term structure literature documents that the slope of the yield curve also varies for other reasons.[5] For example, Section 1.1 notes that market participants have information about expected future changes in policy rates that is not created by inertia. This information creates the kind of predictability that Rudebusch treats as evidence of inertia. In addition, the compensation that investors require to bear interest-rate risk also changes over time, leading to changes in the slope of the term structure. This variation attenuates the predictability that Rudebusch attempts to find, and can even reverse the sign of the predictability. Therefore the term structure regressions studied by Rudebusch and those who follow his approach such as Coibion and Gorodnichenko (2012) are uninformative about the magnitude of inertia.

By contrast, with regression (15), any news about expected future policy rates that is orthogonal to news about the current policy rate does not contaminate the coefficient estimate. It goes into the residual. Similarly, news about risk premia goes into the residual unless it is correlated with news about the current policy rate.

1.2.2 Adding some observed macroeconomic news

Now assume that in addition to observing innovations in expected policy rates, we observe the innovation in one or more of the factors driving the target rate. For concreteness, assume we observe the innovation to factor n. Project innovations in the expected policy rate on the observed factor innovation,

$$(E_t - E_{t-1})\, i_{t+j} = b_j \eta_{n,t} + e_{j,t}. \tag{16}$$

The regression coefficient is

$$b_j = (1-\rho)\phi_n f(j; \rho, \Upsilon_{n,j}). \tag{17}$$

The residual picks up all other factor innovations at time t. Estimation in practice replaces the physical-measure expectations with equivalent-martingale expectations. As with (15), the term structure of coefficients for different horizons j provides a credibility test for high inertia. Section 3.3 implements this type of regression.

[5]See, e.g., Singleton (2006).

2 Data

The empirical analysis in Section 3 uses a combination of daily term structure data and FOMC-cycle macroeconomic data.

2.1 Futures

Trading of Fed funds futures contracts begins in October 1988. Bloomberg maintains daily closing prices beginning in December 1988. I use daily closing prices from Bloomberg that span January 1989 through December 2025. Contracts pay based on calendar-month averages of daily effective Fed funds rates. Changes in the contract price from day to day correspond to changes in $\mathcal{Q}$-measure expectations of calendar averages of future fund rates.

Owing to both the monthly averaging and the timing of FOMC meetings, working with these data requires some care. First, we need notation.

m_t :	index of calendar month for day t
$FF_t^{(h)}$:	day t Fed funds futures rate, contract expiring at the end of month $m_t + h - 1$
τ_t :	day of nearest scheduled FOMC meeting on or after day t

The month index ranges from 1 for January 1989 through 444 for December 2025. The funds rate implied by the price of the nearest-expiration contract is $FF_t^{(1)}$. Daily changes in Fed funds futures rates are

$$\Delta FF_t^{(h)} \equiv \begin{cases} FF_t^{(h)} - FF_{t-1}^{(h)}, & m_t = m_{t-1}; \\ FF_t^{(h)} - FF_{t-1}^{(h+1)}, & m_t = m_{t-1} + 1. \end{cases}$$

I use these data to measure the expected 'near-term' FOMC response to news that arrives on day t. To motivate the desired measure, consider two dates in March 1994, on either side of the FOMC's scheduled meeting on March 22. Market participants use the news that arrives on March 15 to update their predictions of the FOMC's next choice of the funds rate. The FOMC's immediate (i.e., March 22) reaction to the news will affect only a few of the daily rates that determine the average funds rate for March 1994 and affect all of the daily rates that determine the average funds rate for April 1994. Therefore the day-t change in the April futures rate measures the expected near-term FOMC response.

Now consider news that arrives on March 25, after the March FOMC meeting. This news might not affect the FOMC's rate-setting decision until the next scheduled meeting on May 17. If so, the FOMC's reaction to this news will not affect the average funds rate in March or April, partially affect the average funds rate in May, and fully affect the average funds rate in June.

Complicating this narrative is the possibility that the FOMC chooses to meet prior to the regularly-scheduled meeting of May 17; or, more precisely, that market participants assign some positive probability to an early meeting. If market participants think this might happen, they will impound more of March 25 news into the May contract and perhaps some of the news into the April contract. (In fact, the FOMC held a conference call on April 18 to raise the funds rate.) Since we do not know the probability that market participants assign to an early meeting, the day-t change in the June contract rate is still the best measure of the expected near-term FOMC response.

More generally, define the expected near-term change in the Fed funds rate as of day t by

$$\Delta FF_t \equiv \Delta FF_t^{(2+m_{\tau_t}-m_t)}. \tag{18}$$

For 38% (55%) of days in the sample studied here, the upcoming FOMC meeting is in the same (next) calendar month as the daily observation. For the other days the upcoming meeting is two calendar months in the future. Note the (18) is never calculated using the nearest-expiration contract, in contrast to the methodology commonly used to study monetary policy news on FOMC dates. Kuttner (2001) explains why the use of the current-month contract requires assuming that the effective funds rate changes at most once during that month, and does so only on a date known in advance (the FOMC meeting date).

Price data for three-month Eurodollars futures contracts are available on Bloomberg beginning with December 1986, earlier than Fed funds futures data. Following the guidance in Acosta, Brennan, and Jacobson (2024), I switch from Eurodollar futures to SOFR futures at the end of December 2021. Eurodollar contracts are settled using the three-month LIBOR rate at settlement, thus daily changes in the implied rates are changes in $\mathcal{Q}$-measure expectations of three-month LIBOR. I use the first nine contracts that expire on the usual cycle of March, June, September, and December. Daily changes for the first eight contracts are constructed accounting for rollover due to contract expirations (hence the need for nine).

The notation is

$$\Delta 3MON_t^{(h)} \equiv \text{change in the rate implied by the } h \text{ nearest 3-month Eurodollar contract.} \tag{19}$$

The resulting term structure ranges up to 21–24 months ahead, depending on precise expiration dates. Trading of expiring contracts ceases at the end of Monday prior to the third Wednesday of quarterly-cycle months.

Payoffs on SOFR look backward rather than forward. As discussed by Acosta et al. (2024), SOFR contract expirations corresponding to the Eurodollar notation (19) are at $h+1$ rather than h. For notational simplicity I use the Eurodollar notation (19) for both Eurodollar and SOFR futures, while using $h+1$ expirations for SOFR futures.

As with Fed funds futures contracts, we want to consider when news on day t can be impounded into Eurodollar/SOFR futures rates. Continuing with the example used with Fed funds futures, consider news arriving on either March 15 or March 25 1994. A Eurodollar futures contract expired on March 14. None of the active contracts on either March 15 or March 25 will settle until mid-June, well after the FOMC scheduled meetings of both March 22 and May 17. Any near-term reaction by the FOMC to the news will be fully impounded into the three-month LIBOR rate in mid-June, and thus also in the nearest-expiration Eurodollar futures contract.

For the sample studied here, 63% of the daily observations are similar to this example, in the sense that the next scheduled FOMC meeting precedes the next Eurodollar/SOFR futures contract expiration. An additional 30% of the observations have the next contract expiration fewer than 10 days before the next scheduled meeting. In the empirical analysis that follows I do not split samples based on the relative timing of contract expiration dates. In practice, this choice has minimal effects on the results.

2.2 Interest rates

I use daily observations of the Federal funds rate chosen by the FOMC. The language "chosen by the FOMC" distinguishes the time series studied here from the effective Fed funds rate, which is affected by transitory market fluctuations. Through December 16 2008 the rate is constructed by the St. Louis Fed from FOMC meeting transcripts and statements. Beginning with December 17 the rate is the mean of the upper and lower bounds set by the FOMC.

The rates are available on the St. Louis FRED database.

Yields on three-month and six-month Treasury bills are secondary-market yields from the H.15 release, also available on FRED. A one-year Treasury zero-coupon bond yield is interpolated from coupon bond prices by Federal Reserve Board staff using the curve-fitting technique of Gürkaynak, Sack, and Wright (2007). All Treasury yields are converted to annually-compounded rates.

Using the methodology of Haubrich, Pennacchi, and Ritchken (2012), the Federal Reserve Bank of Cleveland estimates expected ten-year real rates using nominal Treasury yields, realized inflation, inflation swap rates, and expected inflation from surveys. The resulting monthly time series is on FRED.

2.3 Macroeconomic data

I use surprises in nonfarm payroll announcements by the Bureau of Labor Statistics as high-frequency macroeconomic news. Surprises through May 1998 are from Money Market Services. Surprises from June 1998 through December 2025 are from Bloomberg.

Lower-frequency macroeconomic news comes from Federal Reserve Board staff forecasts. Staff produce economic forecasts prior to every scheduled meeting of the FOMC. I use the term "Greenbook forecast," although the Fed now includes them in Tealbook A. The Federal Reserve Bank of Philadelphia maintains Greenbook datasets. Forecasts of real quarterly output growth (GNP prior to 1992Q1, then GDP) and the associated implicit price deflator are included in every Greenbook. I use Greenbook data from 1987 through 2020, the latest data publicly available. Greenbooks in this sample contain a term structure of forecasts typically ranging from zero (nowcast) to five quarters ahead.

I use these data to construct macroeconomic news at the six-week horizon. Measure time by regularly-scheduled FOMC meetings indexed by τ. Denote the calendar quarter of FOMC meeting τ as q_τ, and the k-ahead quarter as $q_\tau + k$. Use the notation E^G to refer to a Greenbook forecast. Define Greenbook forecast innovations of inflation and real output growth as

$$\begin{aligned} \eta^G_{\pi,\tau,k} &\equiv \left(E^G_\tau - E^G_{\tau-1}\right) \pi_{q_\tau+k}, \\ \eta^G_{y,\tau,k} &\equiv \left(E^G_\tau - E^G_{\tau-1}\right) \Delta y_{q_\tau+k}. \end{aligned} \tag{20}$$

The G superscripts and the explicit forecast horizons k distinguish these observed innovations from the factor innovations defined by the theoretical model's (4).

The Philadelphia Fed also maintains a dataset of output gap forecasts used by Board staff in the construction of Greenbook forecasts. Output gap forecasts up to five quarters ahead are available for every Greenbook beginning in August 1987. The output gap is the log difference between actual and potential output, measured in percent. For Greenbook τ, the longest-horizon forecast of expected growth in the output gap is denoted

$$E_\tau^G(\Delta g) \equiv E_\tau^G\left(gap_{q_\tau+5} - gap_{q_\tau}\right). \tag{21}$$

3 Empirical Evidence

This section studies expected inertia using both daily data from futures markets and longer-horizon data from FOMC meetings.

3.1 Regression description and interpretation

High-frequency term structure regressions follow the spirit of (15). The expected near-term change in the Fed funds rate defined by (18) serves as the main proxy for the daily innovation in the policy rate on the right side of (15). The dependent variables are contemporaneous daily changes in the term structure of Eurodollar/SOFR futures contracts rates up to eight quarterly contracts ahead. The regressions are

$$\Delta 3MON_t^{(h)} = b_{FF}^{(h)} \Delta FF_t + e_{FF,t}^{(h)}, \quad h = 1, \ldots, 8 \tag{22}$$

Estimates of (22) are restricted to the post-1988 sample owing to the availability of Fed funds futures data. Similar long-short regressions using only Eurodollar futures data replace the right-side variable with the futures rate of the nearest-expiration Eurodollar futures contract,

$$\Delta 3MON_t^{(h)} = b_{3m}^{(h)} \Delta 3MON_t^{(1)} + e_{3m,t}^{(h)}, \quad h = 2, \ldots, 8 \tag{23}$$

The explanatory variable of (22) better captures the near-term monetary policy reaction to news. Therefore I limit estimates of (23) to pre-1989 data. No constant terms are included in these regressions because innovations are on both sides. Including constant terms has no appreciable effect on the results. Asymptotic standard errors of parameter estimates are adjusted for generalized heteroskedasticity.

There is one substantial and unavoidable difference between the motivating theoretical regression (15) and the empirical versions (22) and (23). The explanatory variables for the empirical versions are unexpected changes in an expected near-term policy rate rather than the actual policy rate. This broadens the interpretation of the empirical regressions to include probabilistic inertia. Rather than simply following a deterministic inertial strategy, the Fed could in addition randomize the time at which it reacts. For example, with probability p the Fed responds to news immediately, and with probability $1-p$ the Fed delays responding for a few months. Regressions (22) and (23) cannot distinguish between deterministic and probabilistic inertia.

The goal of this exercise is to better understand the Federal Reserve's monetary policy rule, not deviations from the rule. Deviations, also known as monetary surprises, are realized primarily on days when the FOMC meets and does something unexpected. The regressions (22) and (23) should inform us about the rule rather than monetary surprises. Accordingly, I estimate the regressions excluding days with FOMC meeting news, both scheduled and unscheduled. I also estimate the regressions using only days with news from scheduled FOMC meetings in order to highlight how the anticipated dynamics of the rule differ from the dynamics associated with monetary surprises.

From 1994 onward, FOMC news arrives on the meeting dates (for two-day meetings, on the second day). Prior to 1994, the FOMC did not publicly reveal its decisions. I follow the literature that uses the news-arrival dates of Kuttner (2001) for meetings prior to 1994. I also follow the literature by referring to FOMC news-arrival dates as FOMC meeting dates, although that is strictly true only after 1993.

3.2 Results of unconditional regressions

The introduction discusses Figure 1, which displays estimates of (22). The figure documents the break in the term structure of coefficients after 1991. The results here extend those of Figure 1 by examining earlier and later data, as well as zero-lower-bound (ZLB) periods. All of the evidence appears in Table 1.

The table's first row reports estimates of (23) for December 1986 through December 1988. These results are consistent with minimal expected inertia in the policy rule. The peak response to the shortest Eurodollar futures rate is only 1.1. The response of the 24-month-ahead Eurodollar futures rate is less than one-to-one. The table's second row combines data from 1989 through 1991, which is the date range studied in Panel A of Figure 1. As with the 1986–1988 sample, the response of the 24-month-ahead rate is less than one-to-one. The right-most column in the table reports p-values of tests of the hypothesis that the response of the furthest-expiring rate equals the response of the nearest-expiring rate. Owing to the large number of observations and the high explanatory power, both regressions easily reject the hypothesis of equal responses.

The table splits post-1991 data into six subperiods. Relative to the samples examined in Figure 1, the table adds the two ZLB periods and the post-pandemic sample. The ZLB periods are January 2009 through November 2015 and April 2020 through February 2022. The post-pandemic period ends with December 2025.

Before discussing these additional subperiods, a closer look at the results for 1994 through 2008 illustrates a limitation with the motivating theoretical framework. In this sample, the term structure's response to the near-term Fed funds futures rate reaches a peak at about 12 months. The peak is a little less than twice the initial change in the Fed funds futures rate, which is well below the peak for the regression using 1992–1993 data. More surprisingly, the 1994–2008 point estimate for the shortest-expiration Eurodollar contract is less than one, which is incompatible with inertia as modeled in Section 1.1. If the near-term Fed funds futures rate rises by, say, 10 b.p., and investors anticipate additional future increases, how can the expected month-ahead 3-month yield rise by less than 10 b.p.?

A somewhat broader modeling framework can explain both the apparently anomalous results. Rather than a model with only business-cycle innovations and a single coefficient of inertia, allow for two types of innovations with different inertial coefficients. One type is a business-cycle innovation with high inertia and the other is a highly transitory innovation with no inertia. For example, sometimes the Fed aggressively responds to transitory market disruptions. Investors anticipate this aggressive response will last for only a short time. Regression coefficients average across responses to these two types of news. The Internet Appendix contains a parameterized example that produces coefficients similar to those reported in Table 1 for the 1994–2008 period.

Results for the final subsample of March 2022 through December 2025 are similar to those for earlier non-ZLB periods. However, estimated coefficients for the subsample of December 2015 through March 2020 are noticeably smaller than they are for any of the other post-1991 subsamples. These small coefficients are driven by comovement of futures rates during the first few months of 2020, as Covid was spreading. Recall that Figure 1 displays parameter estimates for a similar sample that ends in December 2019. The Figure 1 estimates are considerably larger than those in Table 1.

Results for the ZLB periods are, in combination, puzzling. Table 1 shows that during the first ZLB period, the estimated responses of more-distant Eurodollar futures rates substantially exceed corresponding estimates prior to this period. Year-ahead and two-year-ahead futures rates respond more than three to one to the near-term Fed funds futures rate. Simple intuition suggests this pattern is inherent in ZLB dynamics with forward guidance. Investors assign a low probability to an immediate response by the Fed to news, with higher probabilities at more distant dates. Yet the estimates for the second ZLB period push back against this simple story. These estimates are much lower than those of the first ZLB period. Instead, they are similar to those for 1994 through 2008.

The evidence of Figure 1 and Table 1 shows conclusively that after 1991 and continuing through 2025, the term structure of Eurodollar/SOFR rates rises strongly in response to changes in shorter-term futures rates. According to the policy framework of Section 1.1, three mechanisms can drive the regime change near the end of 1991. The first two are changes in the anticipated policy function. The inertial coefficient can increase, or the policy rule can shift from emphasizing low-persistence state variables to high-persistence state variables. The third is an increase in the persistence of the fundamental economic variables that determine the policy target.

Given the sharpness of the change in regression coefficients and the lack of any upheaval in macroeconomic fundamentals around 1991 and 1992, changes in the policy rule are the most likely explanations. One way to distinguish a change in expected inertia from a change in the state variables emphasized by the rule is to examine the term structure response to particular types of macroeconomic news. If, holding the type of news constant, the expected persistence of Fed funds innovations rises substantially, an increase in inertia is the most likely explanation. The next subsection examines macroeconomic news.

3.3 Macroeconomic information

Here I examine connections between macroeconomic news and futures term structures at daily and six-week horizons. In brief, the results are consistent a shift in anticipated inertia associated with news about output and inflation.

3.3.1 Monetary surprises

The regressions underlying Figure 1 and Table 1 exclude FOMC meetings, and thus monetary surprises on FOMC meeting days. However, members of the FOMC communicate at times other than FOMC meetings, and can surprise markets at those times. Perhaps the market reaction to monetary surprises changes after 1991. We cannot disentangle monetary surprise news on non-FOMC days from other types of news on those days. But we can examine FOMC days to see if market reactions on those days changes after 1991.

Table 2 reports estimates of regressions (22) and (23) for samples of only regularly scheduled FOMC meeting days, as defined in Section (3.1). The sample periods are identical to those in Table 1. Of course, the sample sizes are much smaller than those in Table 1. The standard errors are correspondingly larger, especially after 2008. Nonetheless, we can confidently conclude that outside of the first ZLB period, there is no evidence that monetary policy innovations are associated with anticipated inertia either before or after 1991. Excluding this ZLB period, the largest point estimate across all the samples is only 1.31.

3.3.2 Nonfarm payroll surprises

Gürkaynak, Sack, and Swanson (2005) examine one-day yield curve responses to the surprise component of many macroeconomic announcements. They find that the one-year forward rate is most responsive to nonfarm payroll announcements. The explanatory power of nonfarm payroll is sufficiently strong to shed light on inertia during the samples studied here, even though the announcements are made at monthly intervals.

Regressions use day t's surprise component of the announcement to explain the day-t change in futures rates. Denoting the surprise with a tilde,

$$\Delta y_t = b\, \widetilde{NFP}_t + e_t, \qquad y_t \in \{FF_t, 3MON_t^{(h)}, h = 1, \ldots, 8\} \tag{24}$$

No constant term appears because both sides of (24) are innovations. Changes in rates are measured in basis points. Days on which the announcements coincide with FOMC meetings are excluded from the sample. Payroll surprises are scaled by their standard deviation over the December 1986 through December 2019 sample, which excludes the huge innovations during the pandemic. Asymptotic standard errors of parameter estimates are adjusted for generalized heteroskedasticity.

Table 3 contains point estimates for the same eight sample periods examined in Tables 1 and 2. The right-most column reports p-values of the hypothesis that the coefficients on the nearest-expiring and 8th-nearest-expiring Eurodollar/SOFR contracts are equal. The results point to weak expected inertia prior to 1992. For example, consider the results for 1987 and 1988. A one standard deviation payroll surprise raises the nearest-expiring Eurodollar futures rate by about 5 b.p., and simultaneously raises the 2nd-nearest rate by about 7 b.p. The two-year-ahead futures rate increases by less than does the nearest-expiring rate. During 1989 through 1991, all of these rates are more sensitive to payroll surprises than they are during 1987 and 1988, but the two sets of estimates exhibit the same term structure shape.

Results for the post-1991 samples exhibit much steeper effects on the term structure of futures rates, along with substantially smaller near-term responses to payroll surprises. For both the 1992–1993 and 1994–2008 samples, a one standard deviation payroll surprise raises the nearest-expiration Eurodollar rate by about 2 b.p. In both samples the year-ahead futures rate exhibits the greatest response, more than twice as large as the response of the nearest-expiration rate. The first ZLB period exhibits extreme inertia, consistent with results in Table 1 for the same period. Results for the second ZLB period are uninformative because the nonfarm payroll surprises during the pandemic were overwhelmingly large, while the responses of the futures rates were muted. Inertia is pronounced in both the two most recent non-ZLB periods.

As a caveat, note that most of the sample sizes are small. Standard errors do not pin down the estimates with high precision. The hypothesis of equal coefficients of the furthest-expiring and nearest-expiring Eurodollar/SOFR futures contracts cannot be rejected at the 10% level for any of the first three samples. Moreover, these standard errors and p-values are valid only asymptotically, a requirement unlikely to be satisfied with such a small number of observations. Therefore these results should be viewed evidence that corroborates the higher-precision estimates of regression (22) rather than results that can stand alone.

3.3.3 Greenbook forecast revisions

The Greenbook forecast innovations defined in (20) correspond to news revealed from the date of the previous Greenbook forecast to the date of the current Greenbook forecast. I therefore measure contemporaneous innovations in Eurodollar futures rates by summing daily changes. Greenbook data are not available after 2020, thus the sample excludes the period when SOFR contracts replace Eurodollar contracts. Denote the release day of Greenbook $\tau - 1$ as $t = \tau_1$ and the day immediately prior to the release of Greenbook τ as $t = \tau_d$. The six-week innovations in Eurodollar futures are

$$\Delta 3MON_{\tau}^{(h)} \equiv \sum_{t=\tau_1}^{\tau_d} \Delta 3MON_{t}^{(h)}. \tag{25}$$

Regressions link these six-week innovations to contemporaneous Greenbook forecast revisions of expected future output growth and inflation. I summarize these revisions by averaging the one-quarter-ahead and two-quarter-ahead forecast revisions. Over the sample periods examined here, innovations at these horizons are the most closely associated with changes in Eurodollar futures. The regressions are

$$\Delta 3MON_{\tau}^{(h)} = b_{\pi}^{(h)} \frac{\eta_{\pi,\tau,1}^{G} + \eta_{\pi,\tau,2}^{G}}{2} + b_{y}^{(h)} \frac{\eta_{y,\tau,1}^{G} + \eta_{y,\tau,2}^{G}}{2} + e_{\tau}^{(h)}, \quad h = 1, \ldots, 8. \tag{26}$$

Both the six-week sum of daily changes in futures rates and the Greenbook forecast innovations are expressed in annualized percentage points.

The columns in Figure 3 display the estimated coefficients for three sample periods. The periods are January 1987 through December 1991, January 1992 through December 2008, and December 2015 through March 2020. The ZLB periods are excluded. The three sample periods have 39, 136, and 35 observations respectively. Two standard error bounds are also displayed. Asymptotic standard errors of parameter estimates are adjusted for generalized heteroskedasticity.

The results are unsurprising, given the evidence presented earlier in this section. There is little anticipated inertia prior to 1992. According to the point estimates, a one percentage point upward revision in expected future output growth raises the nearest-expiration and 2nd-nearest expiration Eurodollar futures rates by 33 and 46 b.p. respectively. Longer-dated

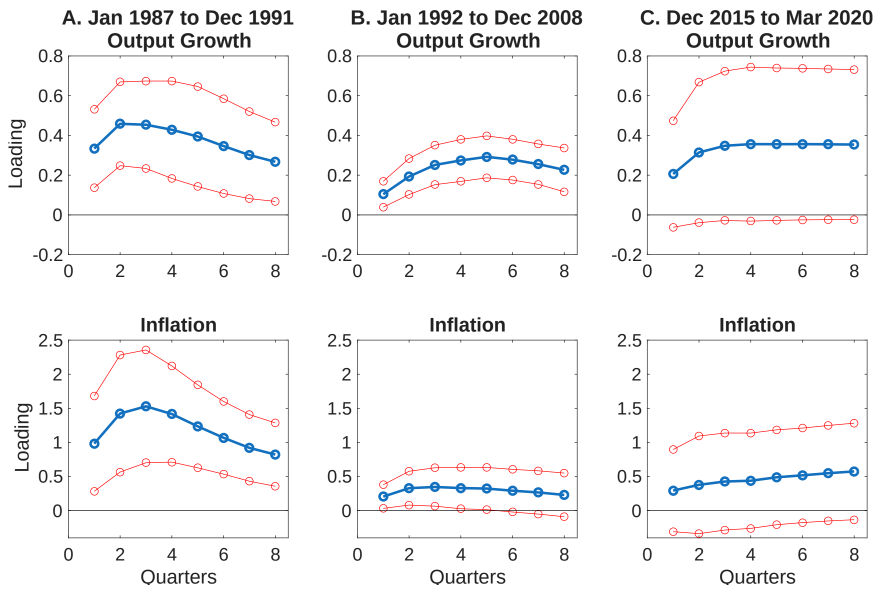

Figure 3. Regressions of changes in Eurodollar futures rates on contemporaneous innovations in Greenbook forecasts. Dependent variables are six-week sums of daily changes of rates implied by Eurodollar futures prices for the first 8 quarterly contracts. The explanatory variables are the averages of innovations in one-quarter-ahead and two-quarter-ahead expected output growth and inflation. Regressions are estimated separately for the sample periods indicated in the figure. Red lines are plus/minus two standard errors.

futures rates respond less, with the two-year-ahead rate rising by only 27 b.p. A similar pattern holds for a one percentage point upward revision in expected future inflation.

Expected inertia increases after 1991. The 1992 through 2008 period offers the strongest evidence. The point estimates indicate that a one percentage point upward revision in expected future output growth raises the nearest-term Eurodollar futures rate by only 10 b.p. The peak response of 29 b.p. is reached with the 5th-nearest contract. The hypothesis that the coefficients for the nearest-contract and two-year-ahead contract are equal is rejected at the 3% level.[6] The corresponding term structure of estimated coefficients for inflation news begins at 21 b.p. for the nearest-expiration contract, and exceeds that level out to the two-year-ahead rate. For the 12/2015 through 3/2022 sample, the term structure of estimated coefficients steadily rises with contract horizon out to two years ahead. However, the standard errors are too large to draw any reliable conclusions.

[6]This test statistic is not displayed in the figure.

3.4 State dependence

The model of Section 1.1 does not allow for state-contingent inertia. Other research generalizes the fixed-coefficient partial adjustment model of the Fed's policy rule. Florio (2006) and Aasstveit, Cross, Furlanetto, and van Dijk (2024) argue that the magnitude of inertia depends on the business cycle, and in particular, on whether the Fed is in an easing or tightening cycle.

I test the restriction of no state-dependence in my empirical setting by generalizing regression (22). Day-t sensitivities of Eurodollar futures rates to the near-term Fed funds rate are allowed to depend on four conditioning variables. The first is the level of the funds rate on day $t-1$, denoted i_{t-1}. The second is the Federal Reserve's forecast of an expected change in the output gap, as defined in Section 2.3. The forecast for day t is the most recent Greenbook forecast made at or prior to day t. Formally,

$$E_t^G(\Delta g) \equiv E_\tau^G(\Delta g), \quad \tau = \max(\tau) \ s/t \ \tau_1 \leq t. \tag{27}$$

The maintained assumption is that this forecast is in the information set of market participants at day t, so their conditional expectations of inertia may depend on it. Both the level of the funds rate and the expected growth of the output gap capture the current stage of easing/tightening cycles.

The third and fourth conditioning variables are estimates of investors' perceptions of the policy rule's sensitivity to output and inflation. Bauer et al. (2024a) construct these estimates using monthly Blue Chip forecasts of output growth, inflation, and interest rates.[7] These sensitivities determine the relative importance of output and inflation news to innovations in expected future policy rates. The conditioning variables for day t are the estimates for day t's calendar month.

Denoting the estimated sensitivities to output and inflation by $\hat{\phi}_{g,t}$ and $\hat{\phi}_{\pi,t}$ respectively,

[7] Thanks to the authors for sharing their estimates. They produce two sets of estimates. Regressions here use their estimates for a non-inertial policy rule. Results using their estimates for an inertial rule are much weaker than those reported here.

the regression is

$$\Delta 3MON_t^{(h)} = \left(b_1^{(h)} + b_2^{(h)} E_{t-1}^G(\Delta g) + b_3^{(h)} i_{t-1} + b_4^{(h)} \hat{\phi}_{g,t-1} + b_5^{(h)} \hat{\phi}_{\pi,t-1}\right) \ \Delta FF_t + e_t^{(h)}, \quad h = 1, \ldots, 8. \tag{28}$$

To simplify interpretation of the coefficients, all conditioning variables are standardized to mean zero and unit variance. The sample period for the regression begins in January 1992, when perceived inertia shifts upward. It ends in February 2020, just prior to the pandemic. Greenbook data are available through 2020, but the extreme outliers of (27) associated with the pandemic significantly affect the results. The sample excludes all FOMC meeting dates. Standard errors are adjusted for generalized heteroskedasticity but not for the generated regressors.

Table 4 reports estimation results. They lead to two conclusions about conditional sensitivities of Eurodollar futures rates to the near-term futures rate. First, conditional sensitivities are considerably higher in tightening cycles (when expected growth in the output gap is high) than in easing cycles. Second, conditional sensitivities are higher when the perceived policy rule is more closely tied to output than inflation.

Consider, for example, the Eurodollar futures rate for the 4th-nearest (year-ahead) contract. The point estimates imply that the mean loading of this rate on a change in the near-term Fed funds futures rate is a little under 2.4. When expected output-gap growth is one standard deviation above its mean (holding the other conditioning information constant), the loading rises to 2.8. When output sensitivity is one standard deviation above its mean and inflation sensitivity is simultaneously one standard deviation below its mean (holding the other information constant), the estimated loading rises to more than 2.9. The p-values versus zero of the relevant cross terms are all less than 1%.

Conditional inertia plausibly accounts for the business-cycle evidence. From a policy-maker's perspective, Panetta (2022) argues that a gradual approach is not always optimal. The evidence of Table 4 tells us that market participants expect that the Fed reacts with more alacrity when the economy is declining. To be clear, these results do not imply that investors expect the Fed to react more aggressively to news of a weakening economy than to news of a strengthening economy. Regression (28) is symmetric with respect to the sign of news at t. Instead, the results say that the Fed tends to move more slowly to both good and bad news when the economy is strengthening.

The parameter estimates on output and inflation sensitivity suggest two possible interpretations. The evidence here cannot distinguish between them. Both interpretations begin with the observation that mechanically, higher loadings of the funds rate on output combined with lower loadings on inflation make the funds rate relatively more responsive to output than inflation. The first interpretation is that innovations to the expected output gap are more persistent than innovations to expected inflation. The framework of Section 1.1 shows that higher persistence of the driving state variables leads to greater sensitivity of expected future short rates.

The second interpretation is that the policy rule exhibits greater inertia for output than for inflation. One way to formalize such a relation extends policy rule (1). Denote separate inertia parameters for output and inflation as ρ_g and ρ_π respectively. A policy rule with two coefficients of inertia is

$$i_t = c + \phi_g \Psi_{g,t} + \phi_\pi \Psi_{\pi,t} + e_t, \tag{29}$$

where $\Psi_{g,t}$ and $\Psi_{\pi,t}$ are weighted averages of the current and past expected output gap and expected inflation, defined by

$$\Psi_{g,t} \equiv (1-\rho_g)E_t\left(gap_{t+k_g}\right) + \rho_g \Psi_{g,t-1}, \qquad \Psi_{\pi,t} \equiv (1-\rho_\pi)E_t\left(\pi_{t+k_\pi}\right) + \rho_\pi \Psi_{\pi,t-1}. \tag{30}$$

The solutions to (30) are

$$\Psi_{g,t} = (1-\rho_g)\sum_{i=0}^{\infty} \rho_g^i E_{t-i}\left(gap_{t-i+k_g}\right), \qquad \Psi_{\pi,t} = (1-\rho_\pi)\sum_{i=0}^{\infty} \rho_\pi^i E_{t-i}\left(\pi_{t-i+k_\pi}\right). \tag{31}$$

When the inertial coefficients equal a common value ρ, the policy rule reduces to

$$i_t = c + (1-\rho)\sum_{i=0}^{\infty} \rho^i \left(\phi_g E_{t-i}(gap_{t-i+k_g}) + \phi_\pi E_{t-i}(\pi_{t-i+k_\pi})\right) + e_t,$$

which differs slightly from the specification (1).

Figure 4 illustrates the combined effects of the conditioning variables. It plots fitted values of the term in parentheses on the right of (28). These conditional sensitivities are displayed for the nearest-expiration contract, as well as year-ahead and two-year-ahead contracts.

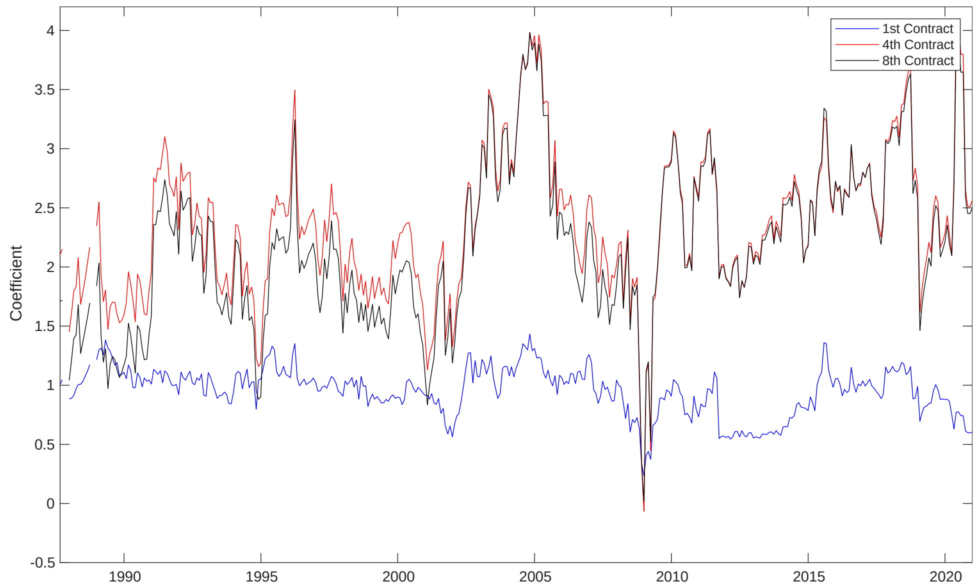

Figure 4. Fitted values of conditional sensitivities of Eurodollar futures rates to changes in a near-term Fed futures rate. Daily changes in three-month Eurodollar futures rates are regressed on the contemporaneous change in a near-term Fed funds futures rate, and interactions of the change with a measure of expected growth in the output gap, the lagged Fed funds rate, and estimates of perceived sensitivity of the funds rate to output and inflation. Estimates use the 1/1992 through 2/2020 sample, excluding days with FOMC meetings. Fitted values are displayed for 12/1987 through 12/2020.

Fitted values are displayed for December 1987 through December 2020. Both endpoints are outside of the estimation sample.

Fitted conditional sensitivities for the year-ahead and two-year-ahead rates vary widely, from a peak near 4.0 in mid-2004 to near zero at the end of 2008. The fitted values surrounding the end of 2008 strongly suggest overfitting, with implausibly low sensitivities. The mean fitted values prior to 1992 are about 2.0 for the one-year-ahead rate and about 1.6 for the two-year-ahead rate. These are much larger than the estimated values reported in Table 1 for the pre-1992 period. Put differently, the lack of anticipated inertia prior to 1992 cannot be explained by the conditioning information examined here.

3.5 Using yields rather than forward rates

Regressions using futures rates provide strong evidence of a large shift after 1991 in the expected inertia of monetary policy. These data do not allow us to study expected inertia prior to 1987. Yet at first glance, it seems that similar regressions using Treasury bill yields and forward rates can be estimated to extend the analysis to the early 1960s.

One difference between changes in Treasury yields and changes in futures rates is that changes in yields are not martingales under either physical or equivalent-martingale measures. Predictable variations in short rates create predictable variations in yields. That said, the predictable component is relatively small for one-day changes. For example, assume investors expect the FOMC to raise the Fed funds rate 25 b.p. at the next meeting in three weeks. Under the expectations hypothesis, the expected one-day change in the three-month bill yield is a little more than 1/4 of a b.p. This expected change is small relative to conditional standard deviations of daily changes in the three-month bill yield.

A more important difference is that Treasury yields, and in particular bill yields, are affected by what we can broadly call distortions. A literature beginning with Park and Reinganum (1986) and continuing through Duffee (1996) and Nagel (2016) shows that bill yields contain liquidity and convenience components. Variation in these distortions contaminates observed high-frequency changes in yields, confounding inferences of expected inertia.

I illustrate this problem using yields on three-month, six-month, and one-year Treasury yields, along with their associated forward rates. The forward rate beginning j months after date t and ending k months after date t is

$$f_{j,k,t} = \frac{k}{k-j} y_t^{(k)} - \frac{j}{k-j} y_t^{(j)},$$

where yield maturities are denoted with superscripts.

Consider regressions of daily changes in the three-month/six-month forward rate and the six-month/twelve-month forward rate on two different measures of daily news in short-maturity rates. The first measure is the daily change in the three-month bill yield,

$$\Delta f_{j,k,t} = b_{j,k} \Delta y_t^{(3)} + e_{j,k,t}, \qquad (j,k) \in \{(3,6),(6,12)\}. \tag{32}$$

The second measure is the daily change in the shortest-expiration three-month futures contract rate,

$$\Delta f_{j,k,t} = b_{j,k}\Delta 3MON_t^{(1)} + e_{j,k,t}, \qquad (j,k) \in \{(3,6),(6,12)\}. \tag{33}$$

Table 5 reports estimates of these regressions for various sample periods. To conserve space, the table does not include estimates for the two ZLB periods. Results for (32) and (33) are in the rows labeled "Treasury Yield" and "Futures Rate" respectively. The results point to large distortions in the three-month bill yield for most of the overall sample.

For example, consider the sample from 1994 through 2008. Estimates of the yield regression (32) are about 0.25 for both the 3-month/6-month forward rate and the 6-month/12-month forward rate. By contrast, corresponding estimates for (33) are around 0.9 and 1.3 respectively. The 2022–2025 sample exhibits similar wedges between coefficient estimates of the yield regressions and coefficient estimates of the futures regressions.

We could attempt to undo the effects of the distortions if they were constant over time. However, the table shows they are not. During the 1992–1993 sample, distortions appear to be minimal. The estimates coefficients using the three-month bill yield are close to those using the futures rate. Thus the coefficients of (32) change over time as both expected inertia changes and as the magnitude of distortions in Treasury yields changes. Without futures market data we cannot disentangle these components.

4 The Early 1990s as a Break Point

The Federal Reserve's transition to transparency begins in early 1994.[8] Greenspan (2001) and Bernanke (2004b) both emphasize the value of transparency in reducing financial market risk by making FOMC decisions more predictable.

This section argues that both the move to greater transparency and the shift to a higher-inertia monetary policy are responses to two lessons Chairman Greenspan draws from the recession and subsequent anemic recovery during 1990 through 1992. First, rate cuts will not de-anchor inflation expectations if market participants anticipate the cuts and think they are consistent with an anti-inflationary policy rule. Second, asset price revaluations can play a central role in business cycle fluctuations through balance-sheet effects on firms and households.

[8] Lindsey (2003), pp. 162-181, describes the sequence of directives adopted by the FOMC from 1994 through 1999 that collectively increase transparency.

These lessons lead to two actions that increase the precision of private-sector forecasts. The first is to increase transparency. The second is to tailor policy actions to more closely align with private-sector forecasts. At the same time, market participants believe that the Fed is already following a high-inertia policy. In a nutshell, the Fed adopts an inertial policy because markets expect it.

4.1 Learning during 1990 through 1992

Recall the evidence from futures markets displayed in Figure 1 and discussed in both the introduction and Section 3.2. In 1992 and 1993, the futures market anticipates much more inertia in the funds rate than it anticipated prior to 1992. Figure 1 cannot tell us why market participants anticipated such high persistence. The most obvious explanation is that participants learned from recent Fed funds dynamics. Figure 5 displays daily values of the Fed funds rate from January 1983 through August 2008. The eyeball test strongly suggests that the Fed followed an inertial policy throughout the 1990s. In a speech titled "Gradualism," Bernanke (2004a), who joined the Fed Board of Governors in 2002, agrees with the eyeball test, stating

> As a general rule, the Federal Reserve tends to adjust interest rates incrementally, in a series of small or moderate steps in the same direction. ... The easing that spanned the 1990-91 recession and subsequent recovery is a better example of how drawn out the process of adjusting rates can be. That episode lasted for more than three years, from June 1989 to September 1992, and involved twenty-four policy actions that cumulated to a total reduction of 675 basis points in the funds rate. Of these twenty-four actions, twenty-one were rate cuts of 25 basis points, and three were cuts of 50 basis points. (p. 1)

Bernanke's rear-view mirror interpretation agrees with press reports at the time. For example, Murray and Wessel (1991) write in *The Wall Street Journal* in December 1991

> For four years, the hallmark of the Fed under Mr. Greenspan has been small, cautious changes in monetary policy; quarter point increments that former Fed Governor Martha Seger once referred to as "baby steps." That strategy, aimed

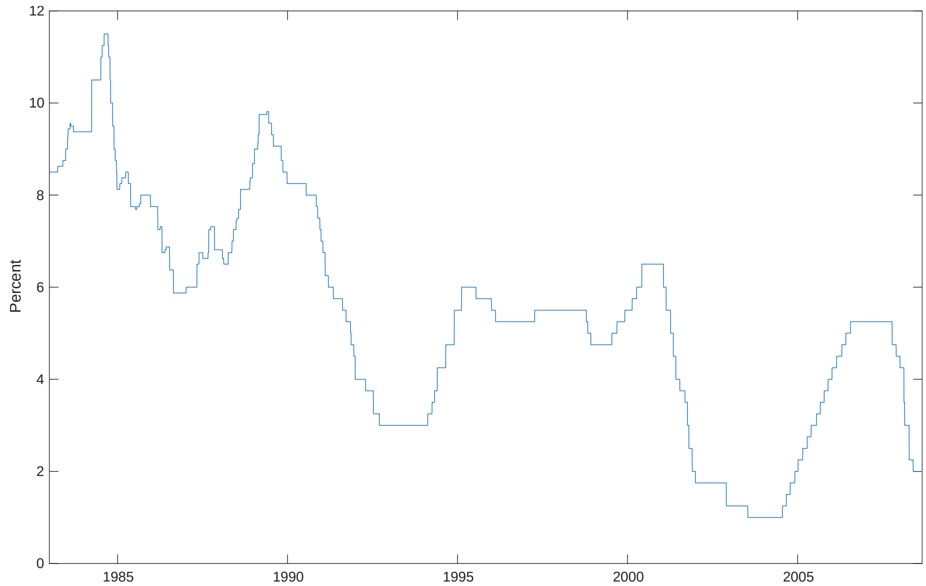

Figure 5. The Federal funds rate from the end of the disinflationary period until the beginning of the global financial crisis. The figure displays the funds rate chosen by the FOMC.

> partly at convincing financial markets of the Fed's commitment to fighting inflation, was designed to make the central bank as unobtrusive as possible. (p. A1)

Congressional testimony in January 1992 by Greenspan (1992) apparently corroborates Bernanke's interpretation: "We at the Federal Reserve have chosen to adjust policy during the past 2-1/2 years mostly in small increments, deciding to accelerate or decelerate the pace of easing through the frequency rather than the magnitude of our adjustments." (p. 5)

Yet transcripts of the FOMC meetings from 1990 through 1992 tell a different story. The FOMC was repeatedly surprised by the recession of 1990–1991 and the continued economic weakness into late 1992, as it cut the funds rate from 8.25% at the beginning of 1990 to 3% in September 1992. These serially-correlated surprises account for the serially-correlated changes in the funds rate. The Internet Appendix contains extensive quotes from the transcripts supporting this conclusion. In particular, at no point does Chairman Greenspan advocate the hallmark of inertia: persistent expected future changes in the funds rate. Instead, at meeting after meeting, his view is that no additional reductions in the funds rate may be necessary.

The NBER Dating Committee identifies the trough of the recession as May 1991. The subsequent recovery is historically weak, leading to repeated rate cuts through September 1992. By July 1992, Greenspan has formulated answers to two key questions concerning the reduction in the funds rate to a level not seen since the early 1970s. First, why has this cumulative reduction not produced higher inflation expectations? Second, why has it not stimulated substantial economic growth?

4.1.1 Inflation expectations

To put the first question in context, Greenbook forecasts of one-quarter-ahead CPI were 3.8% in May 1990 and 3.4% in August 1992. Livingston surveys of expected 10-year CPI inflation were 4.21% in spring 1990 and 3.85% in fall 1992.[9] These declines in expected inflation surprise Greenspan. He states at the December 1991 FOMC meeting:[10]

> I must say, looking back, that I think we've had some lucky things happen to us. One of them is that our policy has been able to rein in inflation at a much more rapid pace than we had contemplated earlier. And it would be a shame if we were to let that get away. (p. 31)

At this time Greenspan is particularly concerned about the Federal Reserve's anti-inflation reputation as reflected in long-horizon inflation forecasts. He ultimately concludes that the gradual decline in the funds rate preserved the Federal Reserve's reputation, and hence accommodated declining long-horizon inflation expectations. More aggressive rate cuts might have destabilized these inflation expectations, driving up long-term nominal yields. From his Congressional testimony of February 19, 1993:[11]

> Some have suggested that the decline in inflation permitted more aggressive moves and, had the downward trajectory of short-term interest rates been a bit steeper, that aggregate demand would have been appreciably stronger. I question that as well. Basing this argument on the lower inflation that has occurred is a *non sequitur*. The disinflation very likely would not have occurred in the context

[9]The Federal Reserve Bank of Philadelphia maintains Livingston survey data.
[10]Board of Governors of the Federal Reserve System (1991).
[11]Greenspan (1993).

> of an appreciably more stimulative policy, and such a policy could have led to higher inflation in the next few years. (p. 8)

Thus one of the key lessons Greenspan takes from this period is the Fed's credibility depends on how well its policy actions align with the market's expectation of those actions. It is important to distinguish the gradual decline in the funds rate during this period from an anticipated inertial policy. The gradual decline was consistent with the Fed's anti-inflation reputation only because each step down was a reaction to additional news of weak economic growth, rather than an inertial response to prior information.

Greenspan supports the 'additional news' interpretation of the FOMC's actions in his Senate testimony on January 29 1992.[12] Responding to Sen. Sarbanes, he states "Now it is the case that we very purposely stopped easing as the economy was coming back in the spring of 1991." (p. 83) An explicitly inertial policy would have affected inflation expectations differently. To take the extreme inertia case, imagine the Fed had announced in October 1990 that it was immediately lowering the funds rate from 8% to 7.75%, and would continue to lower the funds rate over the next two years to 3%. From Greenspan's perspective, this announcement would have severely damaged the Fed's anti-inflation credibility, and long-term yields would have increased substantially.

4.1.2 The recession and weak recovery

When Greenspan recognizes the recession in late 1990, he interprets it as a standard credit crunch. Financial intermediaries cut back their lending to borrowers who previously were viewed as creditworthy. The Internet Appendix contains quotes from FOMC meetings that summarize his credit-crunch interpretation.

However, the anemic recovery during 1991 casts doubt on this perspective. By late 1991 he expresses substantial concern that he might be wrong about the underlying sources of economic sluggishness. At this point he begins to focus on the role of asset prices, bubbles, and the balance sheets of households and firms. He attributes the slow recovery to balance-sheet restructuring by firms and households, induced by declines in values of previously overvalued assets. In January 1993 he testifies before Congress[13]

---

[12] U.S. Senate (1992).

[13] Greenspan (1993), p. 2.

> ...households and businesses have been struggling to redress structural imbalances unparalleled in the postwar period. The speculative bidding up of real estate and other asset prices over the course of the 1980s fostered an excessive accumulation of debt and assets. The subsequent weakening of asset prices in the early 1990s left the balance sheets of many households and businesses strained with debt overload. Banks and other intermediaries that had financed the buildup suffered losses that severely eroded capital. The pressures to work down debt, reinforced by understandably more conservative lending practices, slowed economic growth.

The Internet Appendix contains similar Congressional testimony from Greenspan during late 1991 and 1992.

4.2 Tightening in early 1994

The funds rate was 3% at the end of January 1994. The rate had not changed since the Fed lowered it from 3.25% in September 1992 and had not increased since May 1989. At the FOMC meeting in February 1994, committee members debated whether to immediately raise the funds rate by 25 b.p. or by 50 b.p. Greenspan wraps up the debate by advocating forcefully for a small adjustment. He does not want to surprise financial markets, potentially creating large declines in stock and bond prices. Excerpts of his remarks from that meeting and other FOMC meetings discussed below are contained in the Internet Appendix. At the same meeting he reverses his long-standing opposition to the FOMC publicly announcing its policy directives.[14] He wants market participants to understand clearly what the Fed is doing.

At the next FOMC meeting on March 22 1994, Greenspan explains his reasoning in more detail. He explicitly advocates a series of small increases in the funds rate to achieve his desired target, with these increases implemented immediately after regularly-scheduled meetings. His view is that participants will see a small step, know it is insufficient to achieve the necessary tightening, and therefore anticipate additional small steps at future meetings. He argues these small steps will not damage balance sheets and lead to greater certainty on the part of households and firms.

Two permanent changes to FOMC procedures soon follow these meetings. First, beginning with the May 1994 meeting, the staff Bluebook (now Tealbook B, a document describing

[14]The exception is announcements of changes in the rate charged by the Fed's discount window.

monetary policy alternatives for the FOMC) prominently discusses near-term and medium-term expectations of changes in the funds rate implied by Fed funds futures prices. Second, the FOMC announces in February 1995 that all changes in monetary policy will be immediately publicly announced.

Of course, this new policy framework does not guarantee that Fed policy actions are always anticipated. For example, the cumulative 300 b.p. increase in the funds rate from February 1994 through January 1995 greatly surprises the Treasury market. See Kliesen (2025) for a recent review of the episode. On average, though, market predictions of near-term Fed policy actions are much more accurate beginning in 1994 than earlier. Lang, Sack, and Whitesell (2003) show that from 1994 through 2000, one-month-ahead and two-month-ahead changes in the monthly average effective Fed funds rate are strongly forecastable with Fed funds futures contract prices. They also show that forecastability using futures prices is much weaker during 1989 through 1993.

The above discussion points to the post-1993 period as one in which the inertial monetary policy rule is, in some sense accidental. The seeds of the equilibrium are planted during the drawn-out easing during the 1990–1991 recession and its aftermath. Market participants see 24 successive reductions in the Fed funds rate and reasonably, although incorrectly, conclude the Fed follows an inertial strategy. The Fed simultaneously places a new emphasis on meeting the market's expectations, and chooses to follow the inertial strategy.

5 Evaluating Standard Estimation of Inertia

This section discusses why standard methods of estimating monetary policy inertia are unreliable. These methods typically estimate the policy rule directly, either with OLS using real-time expectations or with instruments that are correlated with these expectations, such as lagged realizations. I illustrate OLS estimation of the inertial monetary policy rule (1) using Greenbook forecasts of one-quarter-ahead inflation and the output gap.

Time is measured at the frequency of scheduled FOMC meetings from August 1987 through 2019, excluding the ZLB period from December 2008 through December 2015. The funds rate and the inflation rate are measured in percent/year. The output gap is measured in percent. Estimation with OLS produces

$$i_t = \underset{(0.069)}{-0.053} + \underset{(0.013)}{0.071}\ E_t^G\left(gap_{q_t+1}\right) + \underset{(0.045)}{0.111}\ E_t^G\left(\pi_{q_t+1}\right) + \underset{(0.015)}{0.949}\ i_{t-1} + e_t, \tag{34}$$

$$T = 203,\ R^2 = 0.987.$$

Asymptotic standard errors, in parentheses, are adjusted for one lag of moving-average residuals using Newey and West (1987).

The estimated coefficient on the lagged funds rate implies extraordinarily high inertia. It takes more than 13 FOMC meetings (more than a year and a half) for half of an innovation in the target rate to be impounded into the funds rate. The asymptotic standard error indicates the estimate is highly precise. If the true coefficient is two standard errors less than the estimate, it still takes more than a year for half of an innovation in the target rate to be impounded into the funds rate.

5.1 Omitted variables

Taylor (1993) emphasizes that such parsimonious policy rules exclude substantial complexities. These missing complexities are, from an econometric perspective, omitted variables. The econometrics literature recognizes that coefficient estimates on lagged dependent variables are inconsistent in settings with persistent omitted variables. Most of this literature uses applied microeconomic settings, such as Heckman and Hotz (1989). McKinnish (2005) shows in a general panel data setting that estimated coefficients on lags cannot be used to distinguish between the presence of persistent omitted variables and slow adjustment of the dependent variable.

The monetary policy inertia literature explores the omitted variables problem by adding other variables to the policy rule. The informal logic, which is usually implicit in the literature, is that the omitted variables problem is important in practice only if additional variables lower substantially the coefficient on the lagged policy rate. A "kitchen sink" implementation adds a variety of variables related to monetary policy, such as those in a monetary-model vector autoregression (VAR). Rudebusch (2002) notes that estimating these VARs typically produces "large and significant" coefficients on lagged rates. He interprets this as ruling out an important role for omitted variables other than perhaps for monetary policy shocks.

A more targeted implementation uses theory to identify plausible omitted variables. Observables proxy for these omitted variables. Coibion and Gorodnichenko (2012) use proxies for asset-market conditions, imperfect information, and variations in long-run inflation and long-run economic activity. None of their proxies significantly lower estimates of inertia.

Two limitations make this methodological approach unhelpful. First, theory does not guarantee that estimates of inertia become more accurate when adding proxies correlated with omitted variables. An extremely simple example illustrates that including such proxies can have the opposite effect. The key feature of the example is that the included proxy is related to the first-difference of the true omitted variable. Assume that the Fed sets the funds rate proportional to detrended log output,

$$i_t = \beta y_t, \tag{35}$$

where detrended log output follows an AR(1) process

$$y_t = \delta y_{t-1} + \epsilon_t, \qquad 0 < \delta < 1, \quad \mathrm{Var}(\epsilon_t) = \sigma_\epsilon^2. \tag{36}$$

A simplistic candidate policy rule ignores the role of detrended output, specifying that the policy rate follows an inertial process with noise,

$$i_t = b i_{t-1} + e_t. \tag{37}$$

Estimation of (37) produces a positive estimate of inertia owing to the omitted variable. The population coefficient estimate is the autoregressive coefficient δ in (36). An econometrician recognizes that (37) has an omitted variable. But rather than plugging in output, she plugs in a noisy measure of output growth,

$$x_t = y_t - y_{t-1} + n_t, \qquad \mathrm{Var}(n_t) = \sigma_n^2. \tag{38}$$

The estimated policy rule is

$$i_t = b_1 x_t + b_2 i_{t-1} + e_t. \tag{39}$$

The OLS population estimates of the coefficients are, from standard OLS math,

$$\operatorname*{plim}_{T\to\infty} \hat{b}_1 = \frac{\beta}{1+(\sigma_n^2/\sigma_\epsilon^2)}, \quad \operatorname*{plim}_{T\to\infty} \hat{b}_2 = \frac{1+\delta(\sigma_n^2/\sigma_\epsilon^2)}{1+(\sigma_n^2/\sigma_\epsilon^2)}, \tag{40}$$

with

$$\delta < \hat{b}_2 < 1.$$

Policy rule (39) fits the data better than does (37). As the variance of noise relative to the variance of the output innovation goes to zero, the R^2 of (39) goes to one. Yet although the true rule exhibits no inertia, the estimated rule (39) implies more inertia than does the simplistic rule (37).

The second limitation with this methodological approach is that it offers no solution to the omitted variable problem. It is just a diagnostic. When the diagnostic points to an omitted variable, there is no obvious way to proceed. I illustrate this limitation in the context of (34).

Policy rule (34) does not include a time-varying long-run real rate. I augment the policy rule with the Cleveland Fed's expected ten-year real rate, described in Section 2.2. For each scheduled FOMC meeting I use the most recent observation dated at or prior to the meeting's Greenbook date. Denote the expectations with a "C" superscript to highlight they are Cleveland Fed forecasts. The units are percent/year.

The OLS estimates are

$$i_t = \underset{(0.062)}{-0.171} + \underset{(0.014)}{0.116} E_t^G\left(gap_{q_t+1}\right) + \underset{(0.036)}{0.079} E_t^G\left(\pi_{q_t+1}\right) + \underset{(0.037)}{0.262} E_t^C\left(\overline{r}_{t,t+10yr}\right) + \underset{(0.022)}{0.837} i_{t-1} + e_t. \tag{41}$$

$$T = 203, \; R^2 = 0.990.$$

The estimated coefficient on the lagged funds rate implies much less inertia than does the estimate in (34). Half of an innovation in the target rate is impounded into the funds rate in less than six months (3.9 meetings).

The point of this example is not that the true magnitude of inertia is small. Instead, it shows that (34) is misspecified owing to an omitted variable. Given that (34) is misspecified, there is no particular reason to think that (41) is correctly specified. All we are able to conclude is that the estimates from this standard procedure are unreliable.

5.2 Instrumental variables with innovations

Coibion and Gorodnichenko (2012) offer an innovative solution to the omitted variable problem. Because their solution partially motivates the methodology adopted in this research, I want to clearly distinguish their approach from mine. They estimate inertial policy rules with instrumental variables (IV), using only contemporaneous and lagged structural shocks as instruments. Accurate estimates of inertia require simply that the shocks are strongly correlated with the determinants of the true target rate.

With this IV approach, all variation in the lagged policy rate that is unspanned by the structural shocks drops out. This prevents the lagged rate from acting as a catch-all for omitted variables. Thus, the instruments do not need to span all innovations to the target in order to correctly identify the inertial coefficient.

Coibion and Gorodnichenko (2012) estimate a policy rule similar to the estimated rule (34), although they also include Greenbook-expected real output growth as an explanatory variable. The instruments are lags zero through two of innovations to five plausibly structural variables. They are permanent technology shocks, purified innovations to the Solow residual, news shocks, oil supply shocks, and tax shocks.

The IV estimates they report support the conclusion that the policy function exhibits substantial inertia. However, their regression is uninformative because the instruments do not satisfy the relevance requirement for instrumental variables. The authors do not report first-stage F statistics to help evaluate whether their instruments are weak. Instead, they use Monte Carlo simulations of a dynamic New Keynesian model to show that the structural shocks in New Keynesian model can be used as instruments to identify the model's monetary policy rule.

Using their data, I evaluate the strength of their instruments. Details are in the Internet Appendix.[15] The instruments are largely irrelevant to the endogenous regressors. The Cragg-Donald test statistic for weak instruments is only 0.25, nowhere near any Stock and Yogo (2005) critical values for rejecting the null hypothesis that the instruments are weak. Estimation of their policy rule with Limited Information Maximum Likelihood (LIML), which is more robust to the presence of weak instruments, produces extraordinarily large standard errors.

[15] Thanks to the authors for posting their data on the journal's website.

More broadly, macroeconomic news appears to be only weakly related to the explanatory variables of monetary policy rules. I illustrate this problem by estimating (34) using Greenbook forecast revisions as instruments. The revisions are to the one-quarter-ahead output gap forecast and the one-quarter-ahead inflation forecast. Table 6 reports first-stage and second-stage results using lags zero through two of these forecast revisions as instruments. In a nutshell, the instruments are almost completely useless, just like those used by Coibion and Gorodnichenko (2012). The Cragg-Donald test statistic is only 0.05. Estimation using LIML produces a standard error on the lagged interest rate coefficient of almost 5.

Essentially, this IV approach asks too much of news. My empirical approach relies on news, but does not attempt to estimate a monetary policy rule. Nor, as Section 1.2 explains, does it identify an inertial coefficient. Instead, it looks informally for evidence of inertia using innovations in expected future short rates.

6 Conclusion

Evidence from futures markets reveals a sharp break in the market's forecast of inertia in the Federal Reserve's monetary policy rule. Prior to 1992, markets anticipated modest inertia. Subsequently, markets anticipate much stronger inertia in response to macroeconomic news. This anticipation of high inertia likely had its roots in the recession of 1990 and the subsequent weak recovery, when the Fed steadily cut rates for almost two years. Yet at that time, the Fed was not following an inertial strategy.

Instead, it appears that the market's belief in inertia triggered the Fed's inertial strategy beginning in 1994. Chairman Greenspan, drawing lessons from the same economic conditions of 1990 to 1992, begins to place substantial weight on the principle of not surprising markets. One way he does this is by increasing transparency. Another is by adopting a policy rule that the marketplace already anticipates.

These results strongly suggest that the Fed's high-inertia policy began by accident. Nonetheless, subsequent regimes at the Federal Reserve may have chosen to continue the policy based on optimality considerations. This purely empirical research does not pass judgment on whether the Federal Reserve's strategy is appropriate.

References

Aasstveit, Knut Are, Jamie Cross, Francesco Furlanetto, and Herman K. van Dijk, 2024, Asymmetric gradualism in US monetary policy, Tinbergen Institute Discussion Papers 24-074/III.

Acosta, Miguel, Connor M. Brennan, and Margaret M. Jacobson, 2024, Constsructing high-frequency monetary policy surprises from SOFR futures, FEDS Working Paper 2024-034

Bauer, Michael D., Carolin E. Pflueger, and Adi Sunderam, 2024a, Perceptions about monetary policy, *Quarterly Journal of Economics* 139, 2227-2278.

Bauer, Michael D., Carolin E. Pflueger, and Adi Sunderam, 2024b, Changing perceptions and post-pandemic monetary policy, *Proceedings of the 2024 Jackson Hole Economic Symposium*, Federal Reserve Bank of Kansas City, 285-336.

Bernanke, Ben S., 2004a, Remarks on gradualism, Board of Governors of the Federal Reserve, May 20.

Bernanke, Ben S., 2004b, Remarks on central bank talk and monetary policy, Board of Governors of the Federal Reserve, October 7.

Board of Governors of the Federal Reserve System, 1991, Transcript of the Meeting of the Federal Open Market Committee, Meeting held December 17.

Board of Governors of the Federal Reserve System, 2004, Transcript of the Meeting of the Federal Open Market Committee, Meeting held May 4.

Bocola, Luigi, Alessandro Dovis, Kasper Jørgensen, and Rishabh Kirpalani, 2024, Bond market views of the Fed, NBER Working Paper 32620.

Bocola, Luigi, Alessandro Dovis, Kasper Jørgensen, and Rishabh Kirpalani, 2025, Monetary policy without an anchor, NBER Working Paper 344436.

Bradsher, Keith, 1994, Bigger role for intuition seen at Fed, *New York Times* February 28, D1.

Carvalho, Carlos, Fernanda Nechio, and Tiago Tristão, 2021, Taylor rule estimation by OLS, *Journal of Monetary Economics* 124, 140-154.

Clarida, Richard, Jordi Galí, and Mark Gertler, 2000, Monetary policy rules and macroeconomic stability: Evidence and some theory, *Quarterly Journal of Economics* 115, 147-180.

Coibion, Olivier, and Yuriy Gorodnichenko, 2012, Why are target interest rate changes so persistent? *American Economic Journal: Macroeconomics* 4, 126-162.

Duffee, Gregory R., 1996, Idiosyncratic variation of Treasury bill yields, *Journal of Finance* 51, 527-551.

Florio, Anna, 2006, Asymmetric interest rate smoothing, *Economics Letters* 93, 190–195.

Goodfriend, Marvin, 1991, Interest rates and the conduct of monetary policy, *Carnegie-Rochester Conference Series on Public Policy* 34, 7–30.

Greenspan, Alan, 1992, Testimony before the Committee on Banking, Housing, and Urban Affairs, U.S. Senate, January 10.

Greenspan, Alan, 1993, Testimony before the Committee on Banking, Housing, and Urban Affairs, U.S. Senate, February 19.

Greenspan, Alan, 2001, Remarks on transparency in monetary policy, Board of Governors of the Federal Reserve, October 11.

Gürkaynak, Refet S., Brian Sack, and Eric Swanson, 2005, The sensitivity of long-term interest rates to economic news: evidence and implications for macroeconomic models, *American Economic Review* 95, 425-436.

Gürkaynak, Refet S., Brian Sack, and Jonathan H. Wright, 2007, The U.S. Treasury yield curve: 1961 to the present, *Journal of Monetary Economics* 54, 2291-2304.

Hamilton, James D., Seth Pruitt, and Scott Borger, 2011, Estimating the market-perceived monetary policy rule, *American Economic Journal: Macroeconomics* 3, 1-28.

Heckman, James J., and V. Joseph Hotz, 1989, Choosing among alternative nonexperimental methods for estimating the impact of social programs: The case of manpower training, *Journal of the American Statistical Association* 84, 862-874.

Haubrich, Joseph, George Pennacchi, and Peter Ritchken, 2012, Inflation expectations, real rates, and risk premia: evidence from inflation swaps, *Review of Financial Studies* 25, 1588-1629.

Kim, Jinill, and Seth Pruitt, 2017, Estimating monetary policy rules when nominal interest rates are stuck at zero, *Journal of Money, Credit, and Banking* 49, 585-602.

Kleisen, Kevin L., 2025, Risk management in monetary policymaking: The 1994-95 FOMC tightening episode, *Federal Reserve Bank of St. Louis Review* 107, 1-16.

Kuttner, Kenneth N., 2001, Monetary policy surprises and interest rates: Evidence from the Fed funds futures market, *Journal of Monetary Economics* 47, 523-544.

Lang, Joe, Brian Sack, and William Whitesell, 2003, Anticipations of monetary policy in financial markets, *Journal of Money, Credit, and Banking* 35, 889-909.

Lindsey, David E., A modern history of FOMC communication: 1975–2002, Board of Governors of the Federal Reserve (Authorized for public release by the FOMC Secretariat on 8/19/2009)

Litterman, Robert, and José Scheinkman, 1991, Common factors affecting bond returns, *Journal of Fixed Income* 1, 54-61.

McKinnish, Terra, 2005, Lagged dependent variables and specification bias, *Economics Letters* 88, 55-59.

Murray, Alan, and David Wessel, 1991, Changing its course, the Fed boldly tries to bolster economy, *The Wall Street Journal* December 23, A1.

Newey, Whitney K., and Kenneth D. West, 1987, A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix, *Econometrica* 55, 703-708.

Nagel, Stefan, 2016, The liquidity premium of near-money assets, *Quarterly Journal of Economics* 131, 1927-1972.

Panetta, Fabio, 2022, Normalising monetary policy in non-normal times, speech, SAFE Policy Center at Goethe University, May 25, https://www.ecb.europa.eu/press/key/date/2022/html/ecb.sp220525~eef274e856.en.html.

Park, Sang Yong, and Marc R. Reinganum, 1986, The puzzling price behavior of Treasury bills that mature at the turn of calendar months, *Journal of Financial Economics* 16, 267-283.

Rudebusch, Glenn D., 2002, Term structure evidence on interest rate smoothing and monetary policy ineretia, *Journal of Monetary Economics* 49, 1161-1187.

Rudebusch, Glenn D., 2006, Monetary policy inertia: fact or fiction?, *International Journal of Central Banking* 2, 85-135.

Sardoni, Claudio, and L. Randall Wray, 2006, Monetary policy strategies of the European Central Bank and the Federal Reserve bank of the United States, *Journal of Post Keynesian Economics* 28, 451-472.

Singleton, Kenneth J., 2006, *Empirical Dynamic Asset Pricing*, Princeton University Press.

Stock, James, and Motohiro Yogo, 2005, Testing for weak instruments in linear IV regression," in *Identification and Inference for Econometric Models*, Donald W.K. Andrews, Ed., New York: Cambridge University Press, 80-108.

Taylor, John B., 1993, Discretion versus policy rules in practice, *Carnegie-Rochester Conference Series on Public Policy* 39, 195-214.

U.S. Senate, 1992, Hearing Before the Committee on Banking, Housing, and Urban Affairs on Reappointment of Alan Greenspan, 102 Cong., January 29.

Woodford, Michael, 2003, *Interest and Prices: Foundations of a Theory of Monetary Policy.* Princeton: Princeton University Press.

Table 1. Term Structure Regressions Using Futures Rates, for Days Without FOMC Meetings

The table reports parameter estimates of regressions of daily changes in three-month Eurodollar/SOFR futures rates on contemporaneous changes in shorter-term futures rates. The rates switch from Eurodollar to SOFR in January 2022. Expirations of the Eurodollar futures contracts range from the nearest (expiration within 3 months) to 8th-nearest (24 months). SOFR contracts are spliced appropriately with Eurodollar contracts. For all but one sample, the shorter-term rate is that of a near-term Fed funds futures contract, as defined in Section 2.1. For the earliest sample the shorter-term rate is that of the Eurodollar futures contract with the nearest expiration. Regressions, which do not include a constant term, use only days without FOMC meetings. Asymptotic standard errors, adjusted for generalized heteroskedasticity, are in parentheses. The column labeled "Std Dev" reports the standard deviation of the regressions' explanatory variable. The column labeled "P Value" reports the two-sided significance level of a test that the coefficient for the 8th-nearest contract equals the coefficient for the nearest contract (2nd-nearest for the earliest sample).

Date		Std Dev	Eurodollar/SOFR Futures Contract						
Range	Obs	(b.p.)	Nearest	2nd	3rd	4th	6th	8th	P Value
12/1986 to 12/1988	479	9.4	-	1.10 (0.02)	1.08 (0.03)	1.06 (0.04)	1.01 (0.04)	0.98 (0.05)	0.010
1/1989 to 12/1991	715	4.5	1.26 (0.05)	1.55 (0.06)	1.51 (0.07)	1.36 (0.06)	1.10 (0.06)	0.93 (0.06)	0.000
1/1992 to 12/1993	486	2.3	1.32 (0.07)	1.95 (0.08)	2.41 (0.10)	2.56 (0.12)	2.42 (0.12)	2.16 (0.11)	0.000
1/1994 to 12/2008	3636	2.6	0.90 (0.06)	1.49 (0.08)	1.79 (0.09)	1.91 (0.10)	1.87 (0.10)	1.72 (0.09)	0.000
1/2009 to 11/2015	1688	0.4	1.38 (0.27)	2.08 (0.29)	2.66 (0.36)	3.05 (0.43)	3.45 (0.50)	3.53 (0.52)	0.000
12/2015 to 3/2020	1055	1.8	0.72 (0.08)	0.97 (0.11)	1.07 (0.13)	1.15 (0.15)	1.19 (0.17)	1.19 (0.18)	0.003
4/2020 to 2/2022	468	1.0	0.99 (0.06)	1.50 (0.19)	1.86 (0.25)	1.95 (0.25)	1.88 (0.23)	1.59 (0.20)	0.002
3/2022 to 12/2025	935	2.3	1.57 (0.06)	2.49 (0.19)	2.72 (0.27)	2.70 (0.28)	2.33 (0.23)	1.89 (0.21)	0.092

Table 2. Term Structure Regressions Using Futures Rates, for Scheduled FOMC Meeting Days

The table reports parameter estimates of regressions identical to those described in the notes to Table 1. For this table the samples consist only of days with FOMC meetings.

Date Range	Obs	Std Dev (b.p.)	Eurodollar/SOFR Futures Contract: Nearest	2nd	3rd	4th	5th	6th	8th
12/1986 to 12/1988	17	6.0	-	1.16 (0.11)	1.22 (0.13)	1.20 (0.12)	1.19 (0.13)	1.15 (0.12)	1.18 (0.19)
1/1989 to 12/1991	24	4.1	1.07 (0.10)	1.29 (0.13)	1.14 (0.15)	1.11 (0.15)	1.07 (0.12)	1.00 (0.10)	0.87 (0.08)
1/1992 to 12/1993	16	8.6	0.88 (0.05)	1.06 (0.09)	1.16 (0.13)	1.18 (0.14)	1.17 (0.13)	1.11 (0.14)	0.89 (0.14)
1/1994 to 12/2008	120	5.2	1.06 (0.11)	1.00 (0.14)	0.91 (0.15)	0.81 (0.17)	0.73 (0.17)	0.66 (0.17)	0.60 (0.17)
1/2009 to 11/2015	55	0.8	2.10 (0.70)	2.79 (1.02)	3.42 (1.28)	3.82 (1.43)	4.00 (1.44)	4.05 (1.43)	4.06 (1.48)
12/2015 to 3/2020	34	1.5	0.18 (0.57)	0.04 (0.73)	−0.08 (0.84)	−0.04 (0.83)	−0.13 (0.77)	−0.13 (0.73)	−0.16 (0.59)
4/2020 to 2/2022	15	1.1	0.53 (0.31)	0.22 (0.42)	0.09 (0.58)	0.20 (0.67)	0.35 (0.72)	0.67 (0.77)	1.31 (1.14)
3/2022 to 12/2025	31	2.5	0.24 (0.32)	−0.02 (0.43)	−0.40 (0.57)	−0.67 (0.69)	−0.72 (0.72)	−0.66 (0.68)	0.30 (1.39)

Table 3. Regressions of Daily Changes in Futures Rates on Nonfarm Payroll Surprises

The table reports coefficient estimates of regressions of daily changes in rates implied by futures prices on the surprise component of the nonfarm payroll announcement. Changes are expressed in basis points and the surprise is normalized by its standard deviation. Notes to Table 1 describe the rates in detail. Asymptotic standard errors, adjusted for generalized heteroskedasticity, are in parentheses. The column labeled "P Value" reports the two-sided significance level of a test that the coefficient for the 8th-nearest contract equals the coefficient for the nearest contract.

Date		Near-Term	Eurodollar/SOFR Futures Contract						
Range	Obs	Fed Funds	Nearest	2nd	3rd	4th	6th	8th	P Value
12/1986 to	23	-	4.97	6.94	5.43	5.07	4.59	4.70	0.698
12/1988			(1.26)	(1.52)	(1.43)	(1.34)	(1.14)	(0.99)	
1/1989 to	30	4.82	7.72	11.13	11.06	10.03	7.75	6.75	0.337
12/1991		(0.81)	(1.26)	(1.83)	(2.04)	(2.05)	(1.72)	(1.54)	
1/1992 to	22	1.83	2.52	3.69	5.07	5.49	5.44	4.71	0.118
12/1993		(0.69)	(0.92)	(1.59)	(2.00)	(2.11)	(1.97)	(1.85)	
1/1994 to	176	2.03	2.56	4.99	6.47	7.22	7.12	6.26	0.000
12/2008		(0.25)	(0.32)	(0.59)	(0.83)	(0.97)	(1.08)	(1.00)	
1/2009 to	81	0.35	0.65	2.16	4.37	6.49	9.31	10.37	0.000
11/2015		(0.10)	(0.40)	(0.91)	(1.55)	(2.02)	(2.13)	(1.86)	
12/2015 to	52	0.09	1.30	1.78	2.24	2.64	2.97	3.32	0.039
3/2020		(0.77)	(0.45)	(0.73)	(0.91)	(1.00)	(1.18)	(1.29)	
4/2020 to	23	0.00	0.00	0.01	0.02	0.03	0.04	0.06	0.000
2/2022		(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
3/2022 to	45	1.49	2.72	5.05	6.25	6.62	6.14	5.43	0.000
12/2025		(0.60)	(0.79)	(1.45)	(1.84)	(2.02)	(2.03)	(1.94)	

Table 4. Conditional Term Structure Regressions, 1992–2020

Daily changes in three-month Eurodollar futures rates are regressed on contemporaneous changes in a near-term Fed funds futures rate (ΔFF). The regression coefficient is allowed to depend on Greenbook expectations of the five-quarter-ahead change in the output gap, the lagged Fed funds rate, and the Bauer et al. (2024a) perceived sensitivities of the monetary policy rule to output (ϕ_g) and inflation (ϕ_π). Section 2.1 defines 'near-term' for this regression. The conditioning variables are normalized to zero mean and unit variance. The sample period is January 1992 through February 2020, excluding days with FOMC meetings. Asymptotic standard errors, adjusted for generalized heteroskedasticity, are in parentheses. One, two, and three asterisks represent p-values versus zero of 10%, 5%, and 1% respectively.

Futures Contract	Obs	ΔFF	$\Delta FF\times$: $E(\Delta gap)$	$\Delta FF\times$: Lagged FF	$\Delta FF\times$: ϕ_g	$\Delta FF\times$: ϕ_π	Uncentered R^2
Nearest to	6845	0.94***	0.05	0.13*	0.17***	−0.03	0.44
Expiration		(0.07)	(0.05)	(0.08)	(0.05)	(0.05)	
2nd to	6843	1.66***	0.23***	0.25***	0.18***	−0.19***	0.50
Expiration		(0.08)	(0.06)	(0.09)	(0.06)	(0.06)	
3rd to	6843	2.12***	0.38***	0.25**	0.22***	−0.28***	0.47
Expiration		(0.10)	(0.08)	(0.10)	(0.08)	(0.07)	
4th to	6843	2.36***	0.44***	0.18	0.24***	−0.32***	0.43
Expiration		(0.11)	(0.09)	(0.11)	(0.09)	(0.07)	
5th to	6842	2.42***	0.44***	0.11	0.26***	−0.35***	0.39
Expiration		(0.12)	(0.09)	(0.11)	(0.09)	(0.07)	
6th to	6842	2.41***	0.44***	0.07	0.27***	−0.36***	0.37
Expiration		(0.12)	(0.09)	(0.11)	(0.09)	(0.07)	
8th to	6842	2.23***	0.40***	0.05	0.26***	−0.33***	0.32
Expiration		(0.12)	(0.08)	(0.11)	(0.09)	(0.06)	

Table 5. Term Structure Using Treasury Yields and Forward Rates, for Days Without FOMC Meetings

The table reports parameter estimates of regressions of daily changes in Treasury forward rates on contemporaneous changes in either the three-month Treasury bill yield ("Treasury Yield") or the nearest-expiration Eurodollar/SOFR futures contract rate ("Futures Rate"). Changes are expressed in basis points. Regressions, which do not include a constant term, use only days without FOMC meetings. Asymptotic standard errors, adjusted for generalized heteroskedasticity, are in parentheses.

Date Range	Explanatory Variable		Forward Rate (Dependent Variable)	
(Obs)	Name	Std Dev	3 Month–6 Month	6 Month–12 Month
12/1986 to 12/1991	Treasury Yield	7.47	0.55	0.16
(1166)			(0.09)	(0.06)
	Futures Rate	7.96	0.85	0.47
			(0.04)	(0.03)
1/1992 to 12/1993	Treasury Yield	2.84	0.93	1.14
(477)			(0.08)	(0.12)
	Futures Rate	3.95	0.83	1.08
			(0.05)	(0.08)
1/1994 to 12/2008	Treasury Yield	6.03	0.23	0.25
(3596)			(0.06)	(0.05)
	Futures Rate	3.52	0.87	1.32
			(0.08)	(0.07)
12/2015 to 3/2020	Treasury Yield	2.65	0.25	0.09
(1039)			(0.10)	(0.07)
	Futures Rate	1.98	0.65	0.86
			(0.11)	(0.13)
3/2022 to 12/2025	Treasury Yield	4.13	0.35	0.51
(921)			(0.10)	(0.13)
	Futures Rate	4.21	1.04	1.50
			(0.08)	(0.14)

Table 6. Instrumental Variables Estimation of a Policy Rule

Observations correspond to scheduled meetings of the FOMC. The Fed funds rate just after meeting t is regressed on Greenbook forecasts of the one-quarter-ahead output gap, one-quarter-ahead inflation, and the lagged Fed funds rate. Instruments are lags zero through two of forecast innovations to the output gap and inflation. The sample is December 1987 through December 2019, excluding the ZLB period from December 2008 through December 2015. The table reports F statistics for the hypothesis that the instruments have no explanatory power for the endogenous regressor. It also reports standard 2SLS parameter estimates and Limited Information Maximum Likelihood (LIML) estimates. Standard errors and test statistics are adjusted for one lag of moving average residuals using Newey and West (1987).

Explanatory Variable	F Stat [p-val]	2SLS (Std Err)	LIML (Std Err)
Expected Output Gap	2.56	0.272	0.408
	[0.021]	(0.134)	(1.03)
Expected Inflation	1.91	0.083	−0.378
	[0.082]	(0.325)	(3.17)
Lagged Funds Rate	0.28	0.650	−0.056
	[0.946]	(0.391)	(4.87)

Inertia in the Fed's Monetary Policy Rule
Internet Appendix

Gregory R. Duffee
This version: August 2026

1 An Example of a Policy Rule

Section 3.1 presents evidence that the model of Section 1.1 is too simple. A single inertial coefficient does not appear to apply to all types of innovations to the Fed's target rate.

A trivial extension adds an entirely transitory innovation to the target rate. This can represent brief changes in the policy rate designed to address specific concerns, such as temporary illiquidity in asset markets. For simplicity, the Fed responds with inertia to a single factor,

$$x_t = \delta x_{t-1} + \eta_{1,t}, \qquad \mathrm{Var}(\eta_{1,t}) = 1.$$

This factor operates at a business-cycle frequency. Another source of news leads the Fed to temporarily change the policy rate. The policy rate function modifies (8) in the main text,

$$i_t = (1-\rho)\phi_1 \sum_{k=0}^{\infty} f(k;\rho,\delta)\eta_{1,t-k} + \phi_2\eta_{2,t}, \qquad \mathrm{Var}(\eta_{2,t}) = 1,$$

where the scaling function is defined by (11) in the main text.

The functional form for innovations in expected policy rates differs slightly from (12) in the main text, because the function for contemporaneous innovations differs from those for expected future innovations. The new form is

$$(E_t - E_{t-1})\, i_{t+j} = \begin{cases} (1-\rho)\phi_1\eta_{1,t} + \phi_2\eta_{2,t}, & j = 0; \\ (1-\rho)\phi_1 f(j;\rho,\delta)\eta_{1,t}, & j > 0. \end{cases}$$

Then the regression

$$(E_t - E_{t-1})\, i_{t+j} = \beta_j\,(E_t - E_{t-1})\, i_t + e_{j,t}$$

has population regression coefficients

$$\beta_j = \begin{cases} 1, & j = 0; \\ \frac{(1-\rho)^2\phi_1^2 f(j;\rho,\delta)}{(1-\rho)^2\phi_1^2 + \phi_2^2}, & j > 0. \end{cases}$$

I illustrate how this model extension can generate patterns of regression coefficients that differ from those displayed in the main text's Figure 2. The parameters are $\delta = 0.9$, $\rho = 0.85$, $\phi_1 = 1$, and $\phi_2 = 0.15$. Figure IA1 plots regression coefficients for this set of parameters.

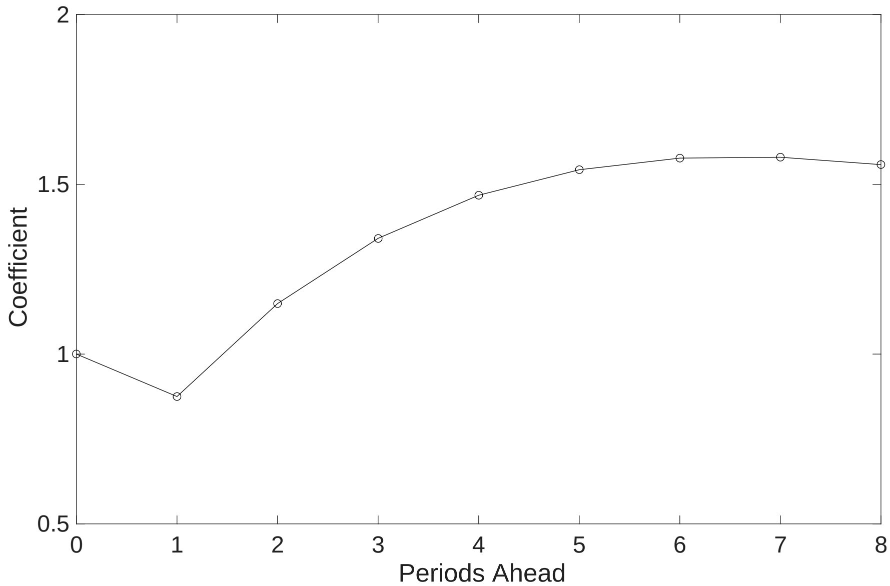

Figure IA1. Model-implied sensitivity of the k-ahead policy rate to a target innovation.

2 A Regression in Coibion and Gorodnichenko (2012)

Coibion and Gorodnichenko (2012) report second-stage results of IV estimation of the Federal funds rate on expected inflation, the expected output gap, expected real output growth, and the lagged funds rate. Column (2) of their Table 5 contains the estimates.

Using the data posted by the authors on the journal's website I calculate statistics for the first-stage regressions, as well as the Cragg-Donald test statistic for weak instruments. The main text reports the Cragg-Donald test. I also calculate the second-stage regression coefficients using standard 2SLS, which are identical to those in the original article. The standard errors I report differ slightly from those in the original article because I use a different Newey and West (1987) lag length for moving-average residuals. Finally, I report Limited Information Maximum Likelihood parameter estimates. All of these results are displayed in Table IA1.

Table IA1. Expanding on a Regression in Coibion and Gorodnichenko (2012)

This table reproduces and extends Table 5, Column (2), in Coibion and Gorodnichenko (2012). At the quarterly frequency, the Fed funds rate is regressed on the Greenbook inflation forecast, the output gap nowcast, the real output growth nowcast, and the lagged Fed funds rate. The instruments are lags zero through two of five types of fundamental shocks. The table reports F statistics for the hypothesis that the instruments have no explanatory power for the endogenous regressor. It also reports standard 2SLS parameter estimates, identical to those in the original article, and Limited Information Maximum Likelihood (LIML) estimates that are more robust in the presence of weak instruments. Standard errors and test statistics are adjusted for one lag of moving average residuals using Newey and West (1987). There are 77 observations from 1987Q4 through 2006Q4.

Explanatory Variable	F Stat [p-val]	2SLS (Std Err)	LIML (Std Err)
Expected Inflation	2.97	0.600	3.010
	[0.001]	(0.180)	(127.8)
Expected Output Gap	0.70	0.176	3.0
	[0.778]	(0.115)	(153.9)
Expected Real Growth	2.13	0.274	−0.7
	[0.020]	(0.060)	(54.7)
Lagged Funds Rate	1.20	0.790	−1.2
	[0.299]	(0.131)	(108.8)

3 Textual Information

This section uses transcripts of FOMC meetings, testimony by Chairman Greenspan to congressional committees, and Fed staff reports to characterize Chairman Greenspan's views about the economic weakness from 1990 to 1992.

3.1 Inertia or serially correlated shocks?

The NBER Business Cycle Dating Committee identified July 1990 as a cycle peak, when the Fed funds rate was 8%. In late October the FOMC reduced the funds rate to 7.75%, beginning a sequence of (primarily) 25 b.p. reductions in the funds rate.

The frequency of 25 b.p. reductions was largely a consequence of the operating procedures at the time. Rather than changing rates only at scheduled meetings, the FOMC routinely held conference calls whenever Greenspan decided that new information required a discussion about changing the funds rate. The FOMC occasionally gave the Open Markets Desk contingent directives, authorizing the Desk to change the funds rate between meetings if certain conditions were satisfied. For example, the reduction of the funds rate to 7.75% in October was a response to a directive to lower the funds rate if and when a "meaningful" Federal budget agreement passed Congress.[1] The Desk implemented the reduction four weeks after receiving the directive.

At the FOMC meeting in November 1990, Greenspan recognized ongoing economic weakness that justified cutting the funds rate yet again. The issues he raised at that time guided his decisions throughout the next 2 1/2 years. He highlighted a tradeoff: responding to weak economic conditions risked damaging the Fed's anti-inflation credibility. He first summarized evidence pointing to the success to date of their anti-inflation stance:[2]

> The one great advantage that we have in all of this I think is that slowing inflation is now finally becoming credible. Certainly, the employment cost index was a very important indicator, and even now there's a lot of question about the zero average hourly earnings number that we saw in the October release. It is all consistent with a significant slowing down, which I think is beginning to show up in the underlying price data. . . . While it's still premature, and indeed I think it's potentially dangerously premature, to assume that we have it beaten, I think that for the first time there are hard numbers that suggest there's something going on . . . (p. 41)

He then argued that an aggressive reduction in the funds rate would put at risk their anti-inflation achievements:

[1] Board of Governors of the Federal Reserve System (1990a), p. 1, describes the directive.

[2] Board of Governors of the Federal Reserve System (1990b).

> Under those conditions, it's very clear to me that if we are perceived as responding excessively easily to all of the other signs that would induce central bank ease, that the risks of the system cracking on us are much too dangerous. I think we have to be awfully careful. (p. 41)

He concluded that a cut of 25 b.p. is appropriate, but that it should not be cut again in the absence of additional news of a weakening economy. The only hint of inertia in his remarks was an asymmetric stance; a willingness to respond more quickly to bad news than good news.

> Nonetheless, I don't think that we have the choice at this stage of not trying to ease into the markets, being fully aware that at the first sign that we get of negative response we're going to have to stop. I don't know whether or not we can do more than a 1/4 point over the next several months. I would say the economy and M2 and the financial markets require it, but we may not have the choice. ... And I would say that at this moment, if we had a money supply that was going up around 5 percent, I would be very concerned about moving in the direction of ease even in this context of weakness.
>
> But with the money supply doing what it's doing and the evidence of the continuous contraction that is going on, I would opt to ease 25 basis points right now and stay asymmetric [toward ease] with the understanding that only if the situation continues to worsen and is manifested in the credit aggregates in one form or another should we move again. But if there is any evidence of significant weakness in the dollar, I think we will have to pull back and harbor the thought; it's not inconceivable to me that at some point if we overdo it, we will have to move back up. Anyway, I would propose that as sort of the "least-worst" policy alternative that I can conceive of at the moment. In summary, it's essentially for us to go down 25 basis points and stay asymmetric and watch the system as closely as we can. (pp. 41-42)

At the December 1990 meeting, Greenspan recommends another 25 b.p. reduction in the Fed funds rate, highlighting the same tradeoff. Weak economic conditions call for greater easing, but the risk of triggering inflation is high. He stated:[3]

> ... we have severe recessionary pressures. But recessions always end. ... At some point we are going to come out of this and we want to make reasonably certain that when we do we're not looking at a degree of liquidity in the system that

[3] Board of Governors of the Federal Reserve System (1990c).

> brings with it [higher] inflation rates and the next downturn much more quickly than is usual. So, I think that it's apparent that we have a fairly difficult next six months ahead. I don't think there's any particular short-term policy uncertainty. My judgment and what I hear as the general consensus around here, if I read it correctly, is that the money supply has become extraordinarily restricted and that we're looking at what is a very major credit contraction. The fact that the prime rate hasn't moved is an indication of the extent of that. And I think there is an inclination to ease up a bit further here. I'm becoming more convinced as the days go by that, while the optimum policy would be to somehow bring the funds rate down and [to generate] the associated credit with it until we get the economy in somewhat of a balanced growth position at which point [short-term rates] could stay down, the chances of being able to implement that are becoming increasingly small. It's just not credible that a central bank can't print money; and the more we try to print it, in figurative terms, the more likely it is that at some point we'll succeed beyond our wildest dreams. And while I would argue strongly that we have to get some downside policy cushion here, namely to make certain that we supply adequate credit into the system, I think we also have to be prepared for the fact that we may, and probably will, overdo it. At some point the equations will come out right and we are going to be required to start pulling back, probably earlier than we might be desirous of doing so. So, I would not at this particular stage leave out the possibility that we may overdo it, but I would not be overly concerned about that provided we are aware sufficiently in advance that that's what's happening. (p. 34)

Through early 1991, Greenspan viewed each reduction in the funds rate as perhaps the final cut in the cycle. For example, at the March 1991 FOMC meeting the funds rate was 6%. Greenspan anticipated an upturn, although he recognizes that a deepening recession will require further rate cuts. He stated:[4]

> By far the highest probability at this stage seems to be that the healing process that we've been observing in recent weeks will continue and will gradually lead into a bottoming out and an economic upturn. . . . That leads me to the second probability . . . in which we could see a failure of the recovery to take hold, continued pressures on profit margins, business confidence falling, and finally a real dive in capital appropriations, which we haven't seen. And that would induce a secondary phase of the recession, which would deepen rather considerably. The probability of that is at this stage still rather moderate to small, but in my judgment non-negligible. I think that leads us then to a policy stance that really gets

[4]Board of Governors of the Federal Reserve System (1991b).

> to this point: If the economy is healing and recovering, then certainly no further easing is required at this stage; but if we get a cumulative erosion, which leads to clear evidence that the capital goods markets are beginning to cave, then I think the proper action is probably a significant drop in the discount rate. (p. 41)

At the August 1991 FOMC meeting, when the funds rate was 5.5%, Greenspan saw no need to lower it further. He argued that anecdotal evidence the FOMC received was wrong:[5]

> ...one of the problems I think we're having is that when a recession is over, by definition, the economy is at the lowest point in a cycle and it feels awful. The anecdotal reports we're getting from a lot of people are a reflection of the fact that the levels of orders, activity, etc. are exceptionally low. It's very interesting to get a sense [of the views] in the political realm; there is a confusion as to whether "the recession ends" means the receding has come to an end or that the economy is back up to normal. I think the overwhelming evidence is that it's the latter [view] that we run into. ...there is clearly no policy purpose that I can see in moving rates lower immediately ...(pp. 36-37)

The NBER Dating Committee will eventually determine May as the trough of the recession. However, the recovery was historically weak. The Greenbook prepared for the December 1991 meeting summarized recent economic activity and the staff forecast:[6]

> The information received since the last meeting of the FOMC suggests that economic activity leveled off during the summer and may well be slipping lower at present. Employment fell across a broad front last month, and industrial production appears to have dropped noticeably after three months of little change. The staff expects real gross domestic product (GDP) to be essentially flat in the current quarter and to decline somewhat in the first quarter of next year. (p. I-1)

The FOMC aggressively reduced the funds rate subsequent to the December meeting from 4.5% to 4%. Again, Greenspan saw no reason to plan for additional rate reductions, aside from an asymmetric stance. In February he stated:[7]

[5] Board of Governors of the Federal Reserve System (1991c).
[6] Board of Governors of the Federal Reserve System (1991a).
[7] Board of Governors of the Federal Reserve System (1992b).

> I think the issue of the extent of monetary policy [easing still] in the pipeline can be looked at in a somewhat different way ... it's my personal view that we probably have done enough to put the economy on track eventually. But I'm willing to acknowledge that we may not have. Since I think the probability that we would want to move interest rates higher or tighten in the intermeeting period approaches zero and that there is at least a nonnegative probability that we might want to ease during the period, I would conclude–if that's the view of the Committee–that something like alternative B [maintaining the funds rate at around 4%] is appropriate, without specifying a presumption that any action is contemplated during the period other than what one would assume under the normal procedures with asymmetric language. (pp. 53-55)

Throughout 1992, news of continued economic weakness led to additional periodic reductions in the funds rate. For example, the Greenbook prepared for the August 1992 meeting stated[8] "Data received after the last FOMC meeting revealed that the economy entered the summer with even less forward momentum than the staff had thought." (p. I-1). The final reduction in September 1992 lowered the rate to 3%.

3.2 Explaining the Weak Recovery

When Greenspan recognized the recession in late 1990, he interpreted it as a standard credit crunch. Financial intermediaries cut back their lending to borrowers who previously were viewed as creditworthy. At the November 1990 FOMC meeting he stated:[9]

> What we have basically is old-fashioned disintermediation; that is, it is not that the net underlying credit demands that finance the GNP are collapsing; they seem to be going up slower than they were but we sure enough seem to be seeing that the intermediation system–not only depository institutions but insurance companies, finance companies, and everybody else–seems to be pulling back. And what we are getting is the obvious tightness, which I think clearly is the major factor in a contraction of M2 and which is only one side of the depository institutions' balance sheets. You can basically see the thing squeezing down as we get loan officers pulling back. (p. 40)

To emphasize, at this point Greenspan sees weakness in loan supply but not loan demand. At the next FOMC meeting in December 1990, he reiterated this view:[10]

[8] Board of Governors of the Federal Reserve System (1992a).

[9] Board of Governors of the Federal Reserve System (1990b).

[10] Board of Governors of the Federal Reserve System (1990c).

> This is in a sense a balance sheet suppression, the type we've all been mentioning. It's really quite interesting to see the process, which is essentially one in which values continue to be under significant pressure. ... So, overall what is occurring, as a number of you have said and one can sense it, is that the fear [felt by] banks and the fear of getting involved in the intermediation process are really putting a big suppression on things. (pp. 33-34)

In his July 1991 Congressional testimony, he interpreted the recession in the same way:[11]

> Going forward, we likely will see a continuation of the "credit correction" now under way. One aspect of this correction is the increased attention paid by regulators and the financial markets to the capital positions of financial intermediaries. The more prudent approach to capitalization and lending decisions is overwhelmingly a healthy development that ultimately will result in strengthened balance sheets for the nation's financial institutions and more assurance of stability of the financial system. In certain areas, however, the credit retrenchment appears to have gone beyond a point of sensible balance. In some cases, lender attitudes and actions have been characterized by excessive caution. As a result, there doubtless are creditworthy borrowers that are unable to access credit on reasonable terms. ... While a single bank may be able to do this without too much trouble, when the entire industry is trying to make the same balance sheet adjustment, it simply cannot be done without massive untoward effects. (pp. 13-14)

However, by late 1991, Greenspan expressed substantial concern that he might be wrong about the underlying sources of economic sluggishness. At this point he began to focus on the role of asset prices, bubbles, and the balance sheets of households and firms. In his December 18 1991 Congressional testimony he noted:[12]

> The upturn in business activity that began earlier this year has clearly faltered. It is apparent that the economy is struggling and that there have been some strong forces working against moderate cyclical revival. (p. 2)

He then discusses evidence of high levels of indebtedness of both businesses and households, summarizing with

[11] Greenspan (1991a).
[12] Greenspan (1991b).

> The bottom line of this brief account is that the national balance sheet has been severely stretched. While most analysts, of course, were aware of the increasingly disturbing trends of rising debt and elevated corporate leverage, it was not clear that these burdens had as yet reached a magnitude that would restrain the American economy from a moderate cyclical recovery in 1991 . . . By late summer, however, with half the recession losses recovered, it became clear that the cumulative upward momentum that characterized previous recoveries was absent. The growing propensity of households to pare debt and businesses to reduce leverage was a signal that the balance sheet restraints, feared by many for a long time, had indeed taken hold, working against the normal forces of economic growth. These events do not necessarily mean that a prolonged period of economic weakness is inevitable, but they do mean that policymakers must consider these unusual forces when shaping their response in the current situation. (p. 3)

Growth remains weak into 1992, elevating his concerns about leverage. At the July 1 1992 FOMC meeting he stated:[13]

> I start with something we've discussed before: namely, to explain the nature of the balance sheet restraint that resulted from a significant rise in assets during the 1980s, funded by debt, and a subsequent decline in market values of assets which created balance sheet impairment. The balance sheet impairment [leads] individuals and businesses to move their cash flow from the purchase of goods and services and investment goods toward debt reduction or other balance sheet repairs, essentially shifting the consumption function in a manner to generate a much higher saving rate and basically a pulling back on investment incentives in the business sector. Now, that is a phenomenon we have seen many times in the past–it's called [the panics of] 1873, 1893, 1907. . . . It's the classic balance sheet/market value crunch which induces a very significant liquidity freeze-up in the banking system and induces a tremendous shift of cash flow toward savings rather than to the purchase of goods and services. And you get the classic Keynesian contraction at that time. (p. 65)

3.3 Ex-post gradualism

Greenspan's balance-sheet perspective implies that weak economic conditions continue until firms and households rebuild their balance sheets. In his view, the amount of time this restructuring takes depends on monetary policy. At the July 1 1992 FOMC meeting he stated:[14]

[13] Board of Governors of the Federal Reserve System (1992c).
[14] Board of Governors of the Federal Reserve System (1992c).

> It strikes me that what we effectively have been doing since 1989, I hope more consciously than otherwise, is to take the same adjustment process–which in the 19th century would have meant that the economy would have gone down sharply, the balance sheets would have been repaired reasonably quickly, and [the economy] would have come back the usual way–and by injecting significant and continuous amounts of liquidity into the system, we in effect have prevented the liquidity freeze-up and have stretched out the adjustment process. The question, of course, is whether there is more adjustment that has to be done this way or less. Or do we know? I suspect that at this point we don't really know. But I do think this explains, or can explain, what basically has been happening in the last two years. When we continue to inject liquidity in the system, the adjustment process takes place; and when we stop injecting liquidity, after a while the economy begins to show symptoms of weakness again. That is another way of saying that the unmedicated economy goes back to the way it used to behave in the 19th century and it begins to get the [liquidity] freeze-up until we re-inject even small amounts of liquidity and the adjustment process continues. (p. 65-66)

In this statement Greenspan began to interpret the gradual reduction in the Fed funds rate during the previous two years as an optimal (if perhaps inadvertent) response to the particular economic conditions. He expanded on this argument early in 1993 through Congressional testimony. The slow adjustment kept inflation expectation from rising, leading to a reduction in long-term rates, thus lowering debt costs for firms and households. Lowered debt costs facilitated their debt restructuring. From his Congressional testimony in February 1993:[15]

> The halting, but substantial, declines in intermediate- and long-term interest rates that have occurred over the past few years have been the single most important factor encouraging balance sheet restructuring by households and firms and fostering the very significant reductions in debt service burdens. And monetary policy has played a crucial role in facilitating balance sheet adjustments–and thus enhancing the sustainability of the expansion–by easing in measured steps, gradually convincing investors that inflation was likely to remain subdued and fostering the decline in longer-term interest rates. (pp. 6-7)

In the same testimony he defended the gradual policy the Fed followed from 1990 through 1992 as optimal:

[15] Greenspan (1993).

> ...a [more aggressive] policy would not have dealt fundamentally with the very real imbalances in our economy that needed to be resolved before sustainable growth could resume. And it would have run the risk of aborting the process of balance sheet adjustment before it was completed. The credibility of noninflationary policies would have been strained, and longer-term interest rates likely would be higher, inhibiting the restructuring of balance sheets and reducing the odds on sustainable growth. (p. 8)

3.4 1994 and beyond

The FOMC raised the funds rate at the conclusion of the February 1994 meeting. Greenspan asked that the members who want a 50 b.p. increase to instead accept a 25 b.p. increase. He stated:[16]

> You know, I rarely feel strongly about an issue, and I very rarely sort of press this Committee. But let me tell you something about what's gnawing at me here ...I would be very concerned if this Committee went 50 basis points now because I don't think the markets expect it. You want to hit a market when it needs to be hit; there is no significant evidence at this stage of imbalances that require the type of action that a number of us have discussed. Were we to go the 50 basis points with the announcement effect and the shock effect, I am telling you that these markets will not hold still ...I am telling you—and I've seen these markets—this is not the time to do this. ...I do request that we be willing to move again fairly soon, and maybe in larger increments; that depends on how things are evolving. (p. 55)

At the same meeting he asked to make a public announcement of the decision.

> I am particularly concerned that if we choose to move tomorrow, we make certain that there is no ambiguity about our move ...I'm very strongly inclined to make it clear that we are doing this but to find a way to do it that does not set a precedent ...I would very much like to have the permission of the Committee to announce that we're doing it and to state that the announcement is an extraordinary event. (p. 29)

At the next FOMC meeting on March 22 1994, Greenspan explained his reasoning in more detail. Market participants do not anticipate an immediate large increase in the funds

[16] Board of Governors of the Federal Reserve System (1994a).

rate. Therefore such an increase has two damaging effects. First, the news hits asset prices, destabilizing markets. Second, the news creates uncertainty about the Fed's policy rule. He stated:[17]

> I think we have to restore policy to neutrality as fast as we can. ... If we were dealing strictly with the economic outlook as it stands now, there is no doubt in my mind that this economy could absorb a very large increase in interest rates without a problem. The difficulty I have is that I don't think the financial system can take a very large increase without a break in its tensile strength– which we strained significantly the last time but did not break. ... there is another characteristic as well. One of the elements that I think we have all been observing with respect to the markets ... is that when we were perceived as moving on the basis of economic data, the markets had a certain sense of what it was we were doing. ... Now they are worried that they don't know when we are going to move, so we have this Sword of Damocles hanging over the market. They don't know whether we are going to move in 2 days, 5 days, or 12 days; they have no basis to judge and they are understandably nervous. (pp. 43-44)

He continued by describing how his preferred change in the funds rate will lead to further changes that are consistent with market expectations:

> A 50 basis point increase would move the funds rate to 3-3/4 percent. In my judgment that would not be perceived of as neutrality or where we ultimately have to be. My own view is that eventually we have to be at 4 to 4-1/2 percent. The question is not whether, but when. If we were to move 50 basis points, I think we would create far more instability than we realize, largely because a half point is not enough to remove the question of where we ultimately are going. I think there is a certain advantage in doing 25 basis points because the markets, having seen two moves in a row of 25 basis points at a meeting, will tend almost surely to expect that the next move will be at the next meeting—or at least I think the probability of that occurring is probably higher than 50/50. If that is the case and the markets perceive that—and they perceive we are going to 4 percent by midyear, moving only at meetings—then we have effectively removed the Damocles Sword because our action becomes predictable with respect to timing as well as with respect to dimension. My own impression, if we decide to move in that direction, is that the last move we might want to make—say, for example, the funds rate was at 3-3/4 percent and we decided 4-1/4 percent

[17] Board of Governors of the Federal Reserve System (1994b).

> might be neutrality—is that perhaps we should add 50 basis points at that point. That would ring the gong as the end and we could in effect withdraw from the race . . . (p. 44)

The logic behind avoiding surprises relies, in part, on Greenspan's view that balance-sheet restructuring by firms and households was central to the economic weakness of 1990–1992. Thus it is worth noting that years later Greenspan (2004) returns to his original view that financial disintermediation was the culprit:

> However, the recovery also was more modest than usual, in large measure because of the notable financial "headwinds" that confronted businesses. Those headwinds were primarily generated by the constriction of credit in response to major losses at banks, associated with real-estate and foreign lending, coupled with a crisis in the savings and loan industry that had its origins in a serious maturity mismatch as interest rates rose. With their access to managed funds threatened and the quality of their loan portfolio–and hence their capital–uncertain, these depositories were most reluctant to lend.
>
> Policy eased gradually but persistently to counter the effects of these developments, with the funds rate falling to 3 percent by September 1992, its lowest level since the early 1960s. The uptilt to the term structure of interest rates in a generally low interest rate environment restored bank profitability and, eventually, bank capital. The credit crunch slowly lifted. (p. 34)

References

Board of Governors of the Federal Reserve System, 1990a, Monetary Policy Alternatives, Prepared for the FOMC, November 9.

Board of Governors of the Federal Reserve System, 1990b, Transcript of the Meeting of the Federal Open Market Committee, Meeting held November 13.

Board of Governors of the Federal Reserve System, 1990c, Transcript of the Meeting of the Federal Open Market Committee, Meeting held December 18.

Board of Governors of the Federal Reserve System, 1991a, Summary and Outlook, Prepared for the FOMC, December 11.

Board of Governors of the Federal Reserve System, 1991b, Transcript of the Meeting of the Federal Open Market Committee, Meeting held March 26.

Board of Governors of the Federal Reserve System, 1991c, Transcript of the Meeting of the Federal Open Market Committee, Meeting held August 20.

Board of Governors of the Federal Reserve System, 1991d, Transcript of the Meeting of the Federal Open Market Committee, Meeting held December 17.

Board of Governors of the Federal Reserve System, 1992a, Summary and Outlook, Prepared for the FOMC, August 13.

Board of Governors of the Federal Reserve System, 1992b, Transcript of the Meeting of the Federal Open Market Committee, Meeting held February 4/5.

Board of Governors of the Federal Reserve System, 1992c, Transcript of the Meeting of the Federal Open Market Committee, Meeting held June 30/July 1.

Board of Governors of the Federal Reserve System, 1994a, Transcript of the Meeting of the Federal Open Market Committee, Meeting held February 3/4.

Board of Governors of the Federal Reserve System, 1994b, Transcript of the Meeting of the Federal Open Market Committee, Meeting held March 22.

Coibion, Olivier, and Yuriy Gorodnichenko, 2012, Why are target interest rate changes so persistent? *American Economic Journal: Macroeconomics* 4, 126-162.

Greenspan, Alan, 1991a, Testimony before the Subcommittee on Domestic Monetary Policy of the Committee on Banking, Finance, and Urban Affairs, U.S. House of Representatives, July 16.

Greenspan, Alan, 1991b, Testimony before the Committee on Ways and Means, U.S. House of Representatives, December 18.

Greenspan, Alan, 1993, Testimony before the Committee on Banking, Housing, and Urban Affairs, U.S. Senate, February 19.

Greenspan, Alan, 2004, Risk and uncertainty in monetary policy, *American Economic Review Papers and Proceedings* 94, 33-40.

U.S. Senate, 1992, Hearing Before the Committee on Banking, Housing, and Urban Affairs on Reappointment of Alan Greenspan, 102 Cong., January 29.