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Perhaps the 1970s FOMC Did What It Said It Did*

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Abstract:

Briefing forecasts prepared for the Federal Open Market Committee (FOMC) are used to estimate changes in the design of U.S. monetary policy and in the implied policy target for inflation from 1970 through 1997. Both estimated policy rate responses and FOMC transcripts are consistent with intermediate targeting of monetary aggregates throughout the Great Inflation of the 1970s. The unpublished FOMC targets for M1 growth are tabulated. Empirical results support an effective inflation target of roughly 7 percent in the 1970s and 3 percent thereafter. A notable difference in the 1970s monetary policies of the US and Germany is the absence of explicit public objectives for US long-run inflation.

Keywords: Asymmetric information; FOMC M1 targets; the Great Inflation; time-varying policy responses.

JEL classifications: E3, E5, N1

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1 Introduction

For more than a decade, discussions of U.S. monetary policy have been organized around variants of the benchmark description advanced by Taylor (1993),

$$r_t = \bar{\rho} + \bar{\pi} + c_2(\pi_t - \bar{\pi}) + c_3(y_t - \bar{y}_t) + \epsilon_{r,t}, \tag{1}$$

where r denotes the short-term policy rate controlled by the central bank; $\bar{\rho}$ is the natural rate of the real interest rate; $\pi - \bar{\pi}$ measures the gap between inflation and the central bank target for inflation; and $y - \bar{y}$ is the log output gap. Although this description was initially based on data from 1987-1992, a period that includes the initial five years of Federal Open Market Committee (FOMC)[1] decisions under the Greenspan tenure, variations have been applied to the behavior of many other central banks and to the historical behavior of the FOMC.[2]

To rationalize the behavior of monetary policy in the 1970s and understand its role in causing the Great Inflation, empirical studies have investigated modifications to one or more arguments of equation (1). However, when evaluating such variations within the framework of a theoretical model, it is important to recognize that alternative calibrations of policy could support a large number of possible policy variations in the 1970s. Assuming equation (1) provides an adequate characterization of the responses of postwar U.S. monetary policy, then the three natural rates (of output, $\bar{y}_t$, inflation, $\bar{\pi}$, and the real interest rate, $\bar{\rho}$) and two parameters of this equation fully describe the determinants of policy. If combinations of variations in the five arguments are considered, alternative calibrations of equation (1) could support 31 possible theories of policy failure during the Great Inflation.[3] The number of theories of monetary policy sources of the Great Inflation would be larger still if equation (1) is generalized to include other macroeconomic variables that may have influenced settings of the federal funds rate historically.

This paper explores a data-based explanation of U.S. policy to evaluate the relative merits of alternative theories of the Great Inflation. By estimating

[1] The FOMC is responsible for the actions of U.S. monetary policy through open market operations.

[2] A sizeable literature explores regression estimates of U.S. policy responses over postwar samples, including Judd and Rudebusch (1998), Taylor (1999), Romer and Romer (2002), and Nelson (2005).

[3] The number of combinations is calculated as $\sum_{i=1}^{5} \binom{5!}{i!(5-i)!} = 31$. Inconclusive calibration exercises of two competing theories of the Great Inflation are discussed in Collard and Dellas (2004). Surveys of alternative interpretations of U.S. inflation in the 1970s include Velde (2004) and Nelson (2005). Various interpretations were explored in presentations at the NBER's "The Great Inflation Conference" in September 2008.

time-varying response coefficients and natural rates, the analysis encompasses most of the alternative variations typically considered in isolation in theoretical formulations as well as most previous empirical studies. One particularly important difference from earlier evaluations of policy responses is that the FOMC inflation target is not assumed to be a known constant, and the estimated responses imply a time-varying *effective* FOMC inflation target. In addition, in contrast to many earlier empirical studies, real-time FOMC briefing forecasts of inflation and the unemployment rate are used to ensure that policy is being conditioned on a view of the economy that is consistent with the data as it was available at the time, and with a view of the outlook as prepared by Federal Reserve Board staff.

In a departure from most Taylor-rule based studies of historical monetary policy, the analysis of this paper is extended explicitly to encompass a monetarist strategy of intermediate money growth targeting. Intermediate targeting of monetary aggregates dominated FOMC policy in the 1970s, and empirical results for the tenures of Arthur Burns and G. William Miller as chairmen of the FOMC (February 1970 through July 1979) are consistent with such a policy.

Surprisingly, previous interpretations of the U.S. Great Inflation do not explore possible consequences of intermediate targeting of M1 growth in the 1970s. One reason may be that money growth targeting did not appear to be a formal objective of U.S. monetary policy until growth rate targets were published by the FOMC in May 1975, in response to the House Concurrent Resolution 133 request for disclosure of annual objectives for money aggregates at Congressional hearings. Indeed, as Milton Friedman (1982) indicated: "The unpegging of government bond prices in 1953 was followed by lip service by the Federal Reserve to monetary growth as a long-run target. However, to the best of my knowledge, it did not set any specific monetary growth targets for itself until 1975, when Congress required it to do so." However, formal, but unpublished, targets for monetary aggregates were adopted by the FOMC beginning in February 1970, vid. Table 1. Moreover, increased emphasis on control of the monetary aggregates has been noted by DeRosa and Stern (1977), who also provide empirical evidence of a clear change in the Federal Reserve System's operating procedure in 1970.

A Taylor-like specification is used in section 2 to estimate the response of the Federal funds rate to FOMC briefing forecasts of inflation and the unemployment rate from 1970 through 1979. Estimated policy responses for the tenures of Arthur Burns and G. William Miller, chairmen of the FOMC from February 1970 through July 1979, are contrasted with those of Paul Volcker and Alan Greenspan,

chairmen during the sample August 1979 through December 1997. Section 3 explores restrictions on the policy rate responses in the 1970s that are consistent with intermediate targeting of money growth rates.

Of course, adopting M1 targets does not automatically imply that the targets will be met, and Broaddus and Goodfriend (1984) document that M1 growth fell outside the published target ranges half of the time in the last half of the 1970s and by a higher proportion during the Volcker disinflation in the 1980s. Section 4 uses extracts from the FOMC *Memorandum of Discussion (MOD)* to indicate FOMC participants repeatedly endorsed money growth intermediate targeting but also, from time to time, identified several practices that plausibly undermined the intermediate targeting procedures, such as optimistic estimates of responses to policy rate adjustments.

Moreover, as observed by Schmid (1999), "the success of monetary policy is measured not in terms of the intermediate target but in terms of the final goal." In forward-looking macro models, long-term inflation expectations are anchored by private sector perceptions of the central bank inflation target, Woodford (2008). An additional characteristic of the US experience with intermediate targeting, shown in section 3, is that perceptions of long-term US inflation continued to rise throughout the 1970s despite the switch to intermediate targeting. Section 4 indicates how the effective inflation target in the 1970s under money growth targeting exceeded ex ante inflation goals consistent with the FOMC money growth targets, due to sizeable unexpected shocks to money velocity and trend output. In the absence of an announced inflation target to anchor longer-run inflation expectations, private sector perceptions of inflation targets have been shown to approach the effective inflation target of the central bank with lags that depend on the learning models of the private sector. The estimated learning models in Kozicki and Tinsley (2001ab) are based on changes in the estimated mean of inflation, and the learning model in Kozicki and Tinsley (2005) is based on filtering predicted responses of the central bank policy rate.

An additional consequence of intermediate targeting, summarized briefly in section 5, is that US intermediate targeting of aggregate money growth rates in the 1970s proved to be a distraction from objective performance measures of ultimate goals, such as longer-run inflation. By contrast, attention to longer-run inflation expectations appears to have helped achieve more successful inflation outcomes in Germany in the late 1970s and, subsequently, in the US under Volcker. As money growth target ranges were missed with about the same frequency in the

US and Germany, two indicators of longer-term inflation expectations in Germany suggest the better performance of German inflation in the 1970s may be due to the announced inflation objective of the Bundesbank. Section 6 concludes.

2 Funds rate responses to real-time forecasts.

In the spirit of several retrospective studies of historical U.S. monetary policy, cited in the introduction, this section provides estimates of responses of the Federal funds rate to real-time predictions of inflation and unemployment, obtained from briefing materials presented to the FOMC.

2.1 *A framework for estimating policy rate responses*

In the absence of policy rate smoothing, the desired setting of the federal funds rate at the FOMC meeting in period t_f is the forward-looking specification

$$r^*_{t_f} \;=\; \bar{\rho}_t + \bar{\pi}_t + c_{2,t}(\pi^4_{t+1|t_g} - \bar{\pi}_t) + c_{3,t}(u_{t+1|t_g} - \bar{u}_t) + c_{4,t}\Delta u_{t|t_g}, \qquad (2)$$

where t_f denotes the date of an FOMC meeting contained in quarter t. As in equation (1), $\bar{\rho}$ denotes the natural rate for the real policy rate and $\bar{\pi}$ is the central bank inflation target, except here both may vary over time. Note also that estimation may allow for time-varying responses, such as the response to inflation, $c_{2,t}$. As the subscript notation indicates, variation in coefficient responses is assumed to change only at quarterly intervals.[4]

Right-hand-side forecast variables in (2) are drawn from the Greenbook multiperiod forecast, formulated in $t_g < t_f$, presented at the FOMC meeting in t_f. As discussed in Kozicki and Tinsley (2006), the frequency of FOMC meetings and Greenbooks was monthly through much of the 1970s but has remained at 8 meetings per year since 1981.[5] Thus, $u_{t+1|t_g}$ is the Greenbook forecast of the unemployment rate in the next quarter of the forecast horizon. The inflation

[4]This is achieved by stacking observations for all FOMC meetings in a given quarter in vectors, see discussions in Kozicki and Tinsley (2006, 2007). In other words, rather than select a subset of Greenbooks (GB) to obtain a quarterly data set, the full set of real-time, multiperiod GB forecasts that match the frequency of meeting-to-meeting funds rate averages is incorporated in a state space model. By contrast, if policy responses were to vary at each FOMC meeting, the coefficient response would be denoted by c_{2,t_f}.

[5]The Greenbook is a staff briefing document presented to FOMC members before a policy meeting of the FOMC. Part I presents the staff multiperiod forecast of economic activity. Construction of the modal forecast and the roles of sectoral specialists and senior staff are discussed in Kalchbrenner and Tinsley (1977) and Kozicki and Tinsley (2006).

measure, $\pi^4_{t+1|t_g}$, is a four-quarter average of inflation up to the next quarter $t+1$ in the forecast horizon, recalling that the FOMC meeting is contained in the current quarter, t. Consequently, real-time estimates of activity in the current quarter and any required preceding quarters, $t-i$, also are drawn from the staff Greenbook "forecast" in t_g.

In contrast to use of the output gap in (1), variation of real activity in (2) is captured by the deviation of the unemployment rate from its natural rate, $\bar{u}$. As noted in Kozicki and Tinsley (2006), FOMC discussions in the 1970s and 1980s of the utilization rate of real economic resources was more typically discussed in terms of unemployment rates. The measure for $\bar{u}_t$ is the real-time time-varying estimate of the natural rate of unemployment constructed from Greenbook forecasts in Kozicki and Tinsley (2006).[6].

To nest the possibility that FOMC policies may have placed a greater emphasis on the change in activity, as suggested by Judd and Rudebusch (1998) and Lansing (2002), the desired policy rate may also be a function of the projected change in the unemployment rate, $\Delta u_{t|t_g}$.

The natural rate of the real policy rate, $\bar{\rho}_t$, is measured as an HP filter of the historical funds rate less the Greenbook forecast of inflation, $r-\pi$.[7] The average of the natural rate construction is 2.6 over the full sample, with $\bar{\rho}_t$ falling below the average value in the mid-1970s and rising above the average in the first half of the 1980s.

Dynamic adjustments of the funds rate are represented by

$$r_{t_f} \;=\; \beta_{5,t}\Delta r_{t_f-1} + (1-\beta_{6,t})r^*_{t_f} + \beta_{6,t}r_{t_f-1} + a_{t_f}, \tag{3}$$

where r_{t_f} denotes the average funds rate in the interval after the FOMC meeting in t_f until the next FOMC meeting. Right-hand-side regressors in (3) include a term capturing any continuation of the most recent meeting-to-meeting change in the funds rate; a partial adjustment of the funds rate level to the desired current setting; and an i.i.d. stochastic shock, a_{t_f}.[8]

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[6]The estimation methodology is also discussed in the appendix of Kozicki and Tinsley (2007)

[7]Following Ravn and Uhlig (2002), the Hodrick-Prescott smoothing parameter is 2^4 x $1600 = 25,600$, as the FOMC has met at least eight times a year during the sample used.

[8]As indicated by the subscript notation, the state space "measurement" error, a_{t_f}, varies with the meeting-to-meeting average of the funds rate.

Combining equations (2) and (3) gives

$$\begin{aligned} r_{t_f} &= \beta_{1,t} + \beta_{2,t}\pi^4_{t+1|t_g} + \beta_{3,t}(u_{t+1|t_g} - \bar{u}_t) + \beta_{4,t}\Delta u_{t|t_g} \\ &\quad + \beta_{5,t}\Delta r_{t_f-1} + \beta_{6,t}(r_{t_f-1} - \bar{\rho}_t) + \bar{\rho}_t + a_{t_f}. \end{aligned} \tag{4}$$

In summary, as shown also in Table 2, the funds rates are meeting-to-meeting averages and denoted by the subscript t_f. The explanatory variables, such as $u_{t+1|t_g}$, are drawn from the Greenbook forecast prepared in t_g for the FOMC meeting t_f, where $t_g < t_f$.

Given the real-time Greenbook forecasts and estimates of the natural rates, $\bar{u}_t$ and $\bar{\rho}_t$, the policy response equation implies an *effective* central bank target for inflation

$$\bar{\pi}_t = -\beta_{1,t}/(\beta_{2,t} + \beta_{6,t} - 1), \tag{5}$$

which is obtained by mapping the reduced-form parameters in (4) to the structural parameters and unobserved inflation target in expressions (2) and (3).

The *effective* inflation target construction of (5) may not necessarily correspond to inflation objectives in the collective minds of FOMC members but is implied by the interpretation of variations in historical policy rates provided by equations (2) and (3). As an inflation target was not announced by the FOMC, (5) could be a reasonable inference by historical observers of movements in the funds rate, if they had had access to the same forecast information and assumptions as the FOMC.[9]

2.2 *Estimated policy rate responses*

Estimated coefficients of the policy response equation, (4), are presented below for two time varying parameter (TVP) specifications. The random walk intercept (RWI) specification allows the intercept term to evolve according to a unit root process, but other coefficients are restricted to be constant. Alternatively, in the stationary coefficients (SC) specification, all coefficients of the policy response equation are allowed to be time-varying, with variation captured by stationary autoregressive movements about fixed means. Use of real-time, multiperiod GB

[9]Distinctions between central bank targets and perceptions of targets by uninformed observers are explored in Kozicki and Tinsley (2001ab, 2005). Differences in assumptions about the natural rate estimates, $\bar{u}_t$ and $\bar{\rho}_t$, can alter the estimate of the effective inflation target. Orphanides (2003, 2004) and others, for example, suggest the main failure of 1970s policy was a severe overestimation of trend output or underestimation of the natural rate of unemployment. By contrast, Kozicki and Tinsley (2006) indicate implied Greenbook underestimates of the natural rate of unemployment, as gauged by CBO retrospective estimates, were modest and confined to the early 1970s.

forecasts in a state space model and TVP estimation methods are discussed in Kozicki and Tinsley (2006).

Summary statistics are shown in Table 3 for two samples. The means of the coefficients, the maximum and minimum of the implied inflation targets, and a steady-state variance decomposition provide summary contrasts among alternative specifications.

The bottom panel of Table 3 displays the estimated FOMC policy responses for the sample August 1979 through December 1997. This sample, which includes tenures of Paul Volcker and Alan Greenspan as chairmen of the FOMC, spans 152 Greenbooks over 74 quarters. The TVP specifications include also shifts in the variance of the measurement error, σ_a^2, to account for the change in operating procedures from 1979Q4 to 1982Q3.[10]

In the four-quarter inflation regressor, $\pi^4_{t+1|t_g}$, inflation forecasts are averaged over the first two quarters of the Greenbook forecast horizon and the two preceding quarters.[11]

The estimated mean policy responses to all regressors, $\bar{\beta}_{i,t}$, including the forecast unemployment gap, $u_{t+1|t_g} - \bar{u}_t$, are generally statistically significant in the bottom panel of Table 3. The time-varying estimate of the long-run policy response to inflation, $c_{2,t}$, remains above one throughout the sample, although it falls somewhat in the 1990s for the SC specification. Also, as noted in the last two columns, the effective inflation target in the Volcker/Greenspan sample is estimated to be 3-4 percent.

The top panel of Table 3 estimates FOMC policy responses for the sample February 1970 through July 1979. This sample spans 115 Greenbooks over 39 quarters and encompasses the tenures of Arthur Burns and G. William Miller as chairmen of the FOMC. There are two principal differences from the estimated policy responses in the bottom panel.

First, the mean responses to inflation in the Burns/Miller sample, as measured by $\bar{\beta}_2$, are about half the size of the responses estimated for the Volcker/Greenspan sample. Given that the mean responses to the lagged funds rate, $\bar{\beta}_6$, are only

[10]The use of a nonborrowed reserves instrument during the 1979-82 interval increased the effective variance of a_{t_f} by introducing shocks from money demand and the banking reserves market, vid. Tinsley, von zur Muehlen, and Fries (1982).

[11]Although longer Greenbook forecast horizons are available in the Volcker/Greenspan sample, estimates are relatively unaffected if the four-quarter inflation average is shifted ahead by two quarters, $\pi^4_{t+3|t_g}$. Also, a likelihood ratio suggests a slight advantage for the specification that contains both forward forecasts and backward real-time estimates, $\pi^4_{t+1|t_g}$.

slightly larger, this suggests that the mean long-run response to inflation, $\bar{c}_2$, is much smaller than the mean inflation response in the later sample. Indeed, the estimated time-varying response to inflation, $c_{2,t}$, falls below unity in the mid-1970s. When that occurs, the estimated inflation target constructed by (5) is generally negative, as confirmed by the inflation target range shown in the last two columns of the top panel of Table 3.

Second, and more consequential to the current interpretation of policy, the mean response to the forecast unemployment gap, $\bar{\beta}_3$, is not significantly different from zero under either the random walk intercept (RWI) or stationary coefficient (SC) specifications. This suggests that interpretations of 1970s policy based on erroneous estimates of the natural rate of real activity may be largely irrelevant.[12] By contrast, the mean response to the forecast change in the unemployment rate, $\bar{\beta}_4$, is statistically significant and about twice (in absolute value) the estimated mean response to inflation, $\bar{\beta}_2$. Implications of this result are explored in the next section.

3 An alternative interpretation of policy in the 1970s

As noted in the introduction, simple policy response equations that relate movements of the policy interest rate, r, to changes in arguments of the central bank preference function, such as inflation and measures of natural rate gaps, are the basis of many useful empirical descriptions of historical monetary policy. However, positing a direct link between the policy instrument and ultimate policy objectives conceals a major component of the design of monetary policy in the 1970s. This section indicates that intermediate targeting of monetary aggregates–a monetarist strategy that dominated FOMC policy in the 1970s–provides a unified interpretation of the Great Inflation, explaining the irrelevance of the natural rate gap regressor and providing a more historically accurate description of policy design in the 1970s.

[12]The absence of a policy response to unemployment gaps also casts doubt on interpretations of 1970s policy based on a difference between the natural rate of unemployment and a central bank target for unemployment, such as posited in the time-inconsistency literature.

3.1 *The gathering influence of monetarism on US monetary policy*

In a collection of influential essays, Milton Friedman (1960) indicated that "I share the doubts that the Federal Reserve has repeatedly expressed about the desirability of using price level stability as an intermediate guide to policy." Instead, he proposed that the central bank pursue constant growth of the money stock. In 1960, a unified measure of the money supply was published in the October Federal Reserve *Bulletin*. In the June 1966 FOMC meeting, the FOMC Policy Directive to the trading desk of the Federal Reserve Bank of New York contained the first "proviso" reference to the required reserves aggregate as a secondary target. Finally, in the second FOMC meeting chaired by Arthur Burns, the Policy Directive adopted at the March 10, 1970 meeting selected the growth of monetary aggregates as principal targets of US monetary policy.

Policy forecasting and FOMC policy discussions in the 1970s were shaped by the two-stage design that is characteristic of intermediate targeting. Greenbook forecasts of economic activity were conditioned on the assumption of a trajectory for the money supply over the forecast horizon, vid. Kalchbrenner and Tinsley (1977).[13] To assist sectoral specialists, the senior staff translated the money supply assumption into staff expectations of bond yields over the forecast horizon.

By contrast, short-run policy options were formulated as competing money growth paths associated with alternative settings of the policy instrument, usually the nominal Federal funds rate. In principle, the competing options for the money supply represented different short-run paths toward the baseline money supply trajectory assumed in the Greenbook. These short-run policy options were presented in a briefing document known as the Bluebook. Each Bluebook contained a brief summary of recent activity in money and banking markets and suggested, generally, three policy options for discussion by the FOMC.[14] Forecasts of money growth associated with alternative policy rate settings appear in the Bluebook presented at the first FOMC meeting chaired by Arthur Burns

[13]Generally, the monetary policy assumption of the Greenbook forecast was the M_1 growth rate target selected at the last FOMC meeting. For example: "That growth rate of money (4%) had been assumed for projection purposes because the Committee had been employing such a rate as a target over the past several months." Partee, FOMC Economist (MOD, 6/23/70, p.31).

[14]An example of staff interpretations of the Bluebook policy options: "Mr. Axilrod observed that among the alternative sets of relationships between monetary aggregates and money market conditions presented in each blue book, there was always one that represented a continuation of the Committee's current longer-run target for the aggregates. There was always another alternative that represented a continuation of prevailing money market conditions." (MOD, 11/20/72, p.52). "Money market conditions" is FOMC terminology for the Federal funds rate.

on February 10, 1970. Although alternative forecasts of the money supply were initially limited to the current quarter, as in the February 4 Bluebook, or also included the next quarter ahead, as in the March 4 Bluebook, Bluebook conditional money supply forecasts were eventually lengthened to four-quarter horizons in early 1975. Table 1 lists the unpublished FOMC targets for M1 growth, from the first FOMC meeting chaired by Arthur Burns through the last FOMC meeting before publication of M1 targets in May 1975.[15]

3.2 *Empirical evidence for intermediate targeting in the Burns/Miller era*

Intermediate targeting of the money supply is summarized by three equations,

$$\begin{aligned} \Delta m_t &= \pi_t + \Delta y_t - \Delta v_t, && (6) \\ \Delta \bar{m}_t &= \bar{\pi}_t + \Delta \bar{y}_t - \Delta \bar{v}_t, && (7) \\ r^*_{t_f} &= \bar{\rho}_t + \bar{\pi}_t + c_{2,t}(\Delta m_t - \Delta \bar{m}_t + (\Delta v_t - \Delta \bar{v}_t)), && (8) \end{aligned}$$

where equation (6) is the monetarist equation of exchange that links Greenbook forecasts of inflation and output growth to the projected growth of the monetary aggregate. Equation (7) is a natural rate variant that indicates what target growth of the monetary aggregate is consistent with the inflation target and the natural rate for output growth. The desired setting of the funds rate at the FOMC meeting in period t_f is defined by equation (8). This is an adjusted variant of intermediate targeting, where monetary aggregate growth is adjusted for the staff prediction of transient velocity growth, $\Delta v_t - \Delta \bar{v}_t$.[16]

Substituting the first two equations, (6) and (7), into the third equation (8), gives the desired funds rate explicitly conditioned on averages of Greenbook forecasts,

$$\begin{aligned} r^*_{t_f} &= \bar{\rho}_t + \bar{\pi}_t + c_{2,t}((\pi^4_{t+1} - \bar{\pi}_t) + (\Delta y^4_{t+1} - \Delta \bar{y}_t)), \\ &= \bar{\rho}_t + \bar{\pi}_t + c_{2,t}\Delta x_{t+1|t_g}, && (9) \end{aligned}$$

[15] Short-run monitoring or "tolerance" ranges were also specified for a variety of measures, including the funds rate, growth in reserves, and growth in money and credit aggregates.

[16] By construction, a persistent shift in trend velocity alters the natural rate estimate, $\Delta \bar{v}_t$. "Shift-adjusted"' monetary aggregate targets, to account for the estimated effects of financial innovations such as the nationwide introduction of negotiable order of withdrawal (NOW) accounts, were not publicly announced until 1981. The transient velocity adjustment, $\Delta v_t - \Delta \bar{v}_t$, of equation (8) approximates the "zone of indifference" or short-run tolerance ranges the FOMC adopted in the 1970s to accommodate transient movements within growth rate target ranges. An early interpretation of the "zone of indifference" is: "Chairman Burns remarked at the last meeting he had initially defined the (short-run) ranges for the aggregates as zones of no action. He had then modified that—in response to Mr. Holmes' remarks—to provide for a movement in the funds rate of up to but no more than 1/8 of 1 percentage point as the aggregates approached their limits. In the event that the aggregates appeared to be moving beyond their limits, however, full and free use was to be made of the range for the funds rate." (MOD, 11/20/72 p. 50).

where $\Delta x_{t+1|t_g}$ is a proxy for the nominal output growth gap using Okun's Law, $\Delta x_{t+1|t_g} = \pi^4_{t+1|t_g} - \bar{\pi}_t - a'\Delta u^4_{t+1|t_g}$ and, as previously, $z^4_{t+1|t_g}$ denotes a Greenbook forecast in t_g of a four-quarter average ending in the next quarter of the forecast horizon, $t+1$.

Note that equation (9) is a restricted version of the desired funds rate equation specified earlier in (2). Three restrictions are required by money growth intermediate targeting: First, the policy response to the unemployment gap is zero, $c_{3,t} = 0$. Second, the difference in the unemployment rate, $\Delta u^4_{t+1|t_g}$, is averaged over the same number of periods as the inflation rate regressor. Third, the long-run policy responses to the inflation average, $\pi^4_{t+1|t_g}$, and to the average of the unemployment rate difference proxy, $-a'\Delta u^4_{t+1|t_g}$, are the same, $c_{2,t}$. The dynamic adjustment of the funds rate is the same as that specified earlier in equation (3).

Three sets of estimates of the policy response equation implied by money growth intermediate targeting are presented in Table 4. The Okun's Law coefficient is based on estimates for the 1970s in Tatom (1978), $a' = 2.2$. Equations in the bottom panel of Table 4 are estimates of the policy response equation when all three restrictions associated with intermediate targeting of the money growth are imposed. The unemployment gap regressor, $u_{t+1|t_g} - \bar{u}_t$, is added to equations in the top panel of Table 4. Similar to the results in Table 3, the estimated mean policy responses to the unemployment gap, $\bar{\beta}_3$, are statistically insignificant. In addition, the average difference in the unemployment rate, $\Delta u^4_{t+1|t_g}$, is added to the equations reported in the middle panel of Table 4. These equations also indicate that the mean policy response of the Burns/Miller sample to the difference in the unemployment rate does not differ significantly from the response expected under money growth intermediate targeting.

Although not shown, the estimated long-run policy responses, $c_{2,t}$, to the nominal-growth proxies, $\Delta x_{t+1|t_g}$, implied by the TVP specifications in the bottom panel of Table 4 move between 0.5 and 0.7 during the 1970s. Thus, the implied long-run responses to inflation are even further below one than those estimated in section 2 for the Burns/Miller sample.

The effective inflation target is estimated to lie between 6.1 and 7.2 percent, and about 6.8 percent on average for the SC specification. Other studies have obtained comparable results, using a variety of approaches, but limiting analysis to available retrospective data rather than real-time Greenbook data. In a two-state Markov-switching set-up, Dueker and Fischer (1996) estimated that the implicit inflation target in the 1970s was on the order of 6 percent. To the extent that low

frequency movements in inflation reflect the effective inflation target, results are also consistent with those obtained by Cogley and Sargent (2005), who, in a VAR with drifting coefficients and stochastic volatilities, estimated that "core inflation" in the 1970s was roughly in a range of 5 to 8 percent.

In the absence of an announced central bank target for inflation, private sector perceptions of the central bank target will approach the effective target with lags that depend on the learning models of the private sector, such as the inflation-based learning models estimated in Kozicki and Tinsley (2001ab) and the funds rate-based learning model in Kozicki and Tinsley (2005).

Differences between the effective central bank target for inflation implied by Greenbook forecasts, $\bar{\pi}_t$, and estimates of private sector perceptions of the central bank inflation target, $\bar{\pi}_t^p$, are charted in Fig. 1. The two thick lines are estimates of the effective inflation target, $\bar{\pi}_t$, for the Burns/Miller era from 1970Q1 through 1979Q2 (from the bottom panel of Table 4), and for the Volcker/Greenspan sample from 1979Q3 through 1997Q4 (from the bottom panel of Table 3). The thick dashed line is a concatenation of real-time survey estimates of long-term inflation expectations by private agents.[17] The thin line is an estimate of the evolution of private sector perceptions of the central bank target for inflation, $\bar{\pi}_t^p$, from Kozicki and Tinsley (2001a).[18]

Fig. 1 suggests that at the beginning of the 1970s, the central bank benefited from private sector perceptions, $\bar{\pi}_t^p$, that provided a low anchor for inflation expectations relative to the effective target for inflation, $\bar{\pi}_t$. Thus, despite policy actions consistent with an elevated inflation target, the rise in inflation may have been moderated by this anchor. However, in the absence of improvements in actual inflation (as shown by the central tendency of inflation, represented in the chart by the HP filter of real-time inflation), private sector perceptions continued to increase toward the effective target, and this moderating factor gradually evaporated. In the 1980s, the situation was largely reversed. The effective inflation target was lowered considerably with the change in policy instituted by Volcker in October 1979, but

[17]Until July 1990, survey estimates are drawn from the Hoey survey of expected inflation in the second five years of a 10-year forecast horizon. The remainder of the series is long-run expected inflation from the Survey of Professional Forecasters, published by the Federal Reserve Bank of Philadelphia.

[18]This estimate is based on multinomial logit aggregation of competing changepoint estimators of $\bar{\pi}_t$. Although this estimate of perceived long-run inflation is similar to the survey of long-term expected inflation, survey information was not used in the estimated learning model of private sector perceptions. As discussed in Kozicki and Tinsley (2001ab), in the case of changepoints, inflation can be nonstationary but not necessarily I(1), and the limit of an infinite-horizon forecast, $lim_{j\to\infty} E_t \pi_{t+j} = \bar{\pi}_t^p$, is not always equivalent to a Beveridge-Nelson trend component.

private sector perceptions of the central bank target for inflation remained elevated in the early 1980s, despite the rapid fall in inflation (and the HP inflation "trend"). At the beginning of the 1980s, the credibility gap between the effective target and the perceived target was about five percentage points, and this gap only slowly closed by the end of the sample.

4 Consequences of money growth intermediate targeting

The most striking outcomes of the TVP specifications of policy in the 1970s are the rather high estimates of the central bank effective target for inflation, $\bar{\pi}_t$, and the uniformly low estimates of the long-run policy responses to inflation, $c_{2,t}$, noted earlier. Intermediate money growth targeting provides a unified explanation of these two characteristics of policy given the observed shocks in the 1970s.

First, when monetary policy targets the growth rate of the money supply, the effective inflation target is vulnerable to two types of fundamental shocks, both of which occurred in the 1970s. Renormalizing equation (7), the effective central bank target for inflation under intermediate targeting is defined by

$$\bar{\pi}_t \;=\; \Delta\bar{m}_t - \Delta\bar{y}_t + \Delta\bar{v}_t. \tag{10}$$

Given a target growth rate for the money supply, $\Delta\bar{m}_t$, the effective inflation target will exceed the ex ante inflation goal consistent with the original money growth target if the central bank is unable to detect a reduction in the natural rate trend growth of output, $\Delta\bar{y}_t$, or an increase in trend velocity, $\Delta\bar{v}_t$. In fact, both these shocks were a feature of the policy environment in the 1970s. Growth of the natural rate output trend slowed in the late 1960s and early 1970s. Subsequently, due to financial innovations fuelled by higher inflation and deregulation of banking and financial markets, the trend of velocity began a long march of upward shifts in the mid-1970s.

A literature review of estimated shifts in US trend productivity is provided in Bullard and Duffy (2004). Real-time estimates of trend productivity growth from 1970-2005 are discussed in Edge, Laubach, and Williams (2007), including available historical estimates from the Council of Economic Advisors (CEA). The latter's estimate of trend productivity fell by about 1.3 percentage points over the 1970s. Real-time errors in the CEA estimates of trend productivity have also been used to support a "natural rate error" interpretation of the 1970s, except money

growth targeting is vulnerable to errors in trend growth rather than the associated cumulative errors in the output gap.

Larger errors were associated with predictions of trend velocity, and these errors are unique to a policy based on money supply intermediate targeting. In the 1970s, the unpredicted shifts in trend velocity were substantial. The December 12, 1980 Bluebook contains an analysis of money demand models. Conditioned on retrospective measurements of explanatory variables, the average annual underestimate of velocity growth over the last half of the 1970s by the 1980 vintage of the staff model was 2.7 percentage points, including errors of 5.3 percentage points in 1975 and 4.1 percentage points in 1976.[19]

The second unusual characteristic of policy in the 1970s is that the estimated long-run policy response to the money supply growth proxy, $c_{2,t}$, remained well below one in the Burns/Miller sample. As shown in Fig. 2, FOMC decisions led to flat or modest meeting-to-meeting adjustments of the policy rate level after 1974, until the large upward adjustments of the policy rate in the initial FOMC meetings chaired by Paul Volcker after October 1979 (not shown).

The passivity of policy through much of the second-half of the 1970s is also illustrated in Fig. 3, where the policy rate is plotted against the Greenbook prediction of the nominal growth proxy, Δx_{t+1}, defined earlier. Even if velocity had been perfectly predicted, variations of the funds rate did not keep pace with Greenbook predicted movements of nominal growth during most of the 1970s.

Passivity of policy needs to be differentiated from contemporaneous critiques of money growth targeting in the 1970s that included criticism of the relatively narrow FOMC ranges on inter-meeting variations of the policy rate, vid. Poole (1975). Clearly, as shown in Fig. 2, tight inter-meeting ranges did not prevent sizable meeting-to-meeting adjustments of the policy rate in 1973-74 and, consequently, are an unlikely source of policy passivity.

Inconsistencies with real-time policy actions and discussions plague other interpretations of the 1970s that attempt to find fault with explicit or implicit constraints on policy rather than with the design of the intermediate targeting policy itself. One interpretation of the 1970s is that the FOMC did not believe it had popular support for large increases in the policy rate, vid. DeLong (1997) and Meltzer (2005). This explanation is not consistent with policy actions in mid-1974, when the funds rate was driven near 13%, nor with discussion in the

[19]Goldfeld (1976) indicates that a representative money demand model of the early 1970s generates larger prediction errors, with an out-of-sample RMSE of 6.3 percentage points from 1974Q1 to 1975Q2.

FOMC *Memorandum of Discussion*:

> "Chairman Burns said he might offer his appraisal of the existing support for current Federal Reserve policy. He agreed that support in Congress was strong; he had been receiving almost no critical mail from that source. Of the letters that reached his desk from individuals across the country, a majority were still commendatory." (MOD, 6/18/74, p.62).[20]

Another possible interpretation is that the FOMC may have become disenchanted with intermediate targeting of the monetary aggregates in the mid-1970s. The role of intermediate targets in operational policy was reviewed in the Stage II report of the Subcommittee on the Directive (1976) distributed to FOMC members in early 1976.[21] The initial portion of this report reviewed a staff proposal that the policy instrument, such as the funds rate or nonborrowed reserves, directly target ultimate objectives, such as unemployment and inflation, relegating the money supply to one of many potential indicators of unobserved movements in ultimate objectives. However, the remainder of the report endorsed the two-stage strategy of intermediate targeting with monetary aggregates. FOMC discussion of this report in the 3/15/76 meeting supported a continuation of intermediate targeting:

> "Mr. Wallich added that if optimal control were applied to monetary policy it would tend to focus attention on such ultimate objectives as full employment and price stability. However, he had strongly endorsed the Subcommittee's recommendation that monetary policy continue to focus primarily on intermediate objectives, rather than on ultimate objectives....In further discussion individual members of the Subcommittee commented on the reasons why they had not favored directly relating an operational instrument, such as nonborrowed reserves or the federal funds rate, to ultimate objectives. These reasons included the difficulty of linking instrumental variables to ultimate objectives, both intuitively or through use of econometric models; the problem of reaching an agreement on necessary tradeoffs among

[20]It might be noted that this, and similar real-time MOD quotes, differ considerably from the retrospective Per Jacobsson Lecture, often cited by policy historians, where Burns (1979) suggests: "As the Federal Reserve, for example, kept testing and probing the limits of its freedom to undernourish the inflation, it repeatedly evoked violent criticism from both the Executive Branch and the Congress."

[21]The Subcommittee was chaired by Governor Holland, with Governor Wallich, President Balles (Federal Reserve Bank of San Francisco), and President Morris (Federal Reserve Bank of Boston) as members.

ultimate objectives; and the complications created by the fact that monetary policy was but one of many influences on the ultimate objectives." (MOD, 3/15/76, p.16)

The FOMC *Memorandum of Discussion* (MOD) suggests several issues that may have contributed to passive policy rate responses to nominal growth gaps.

One possibility is that the FOMC may been optimistic about interest rate elasticities, selecting policy rate adjustments that were too small to reverse predicted nominal growth gaps.[22] In particular, two procedures could have led to effective overstatement of interest rate effects:

In framing final voting choices, FOMC members were free to pick policy rates from one Bluebook option and monetary target ranges from another option. The problem of inconsistent choices from an "a-la-carte menu" was occasionally addressed in Bluebook presentations.

"The blue book can be viewed as a menu of consistent targets....The Committee is, of course, free to choose among the various objectives presented, taking due account of the risks being run. There is the risk, for instance, of choosing incompatible objectives. However, this risk has to be weighed against the probability there will be errors in the staff's estimates of relationships likely to prevail among bank reserves, monetary aggregates, and interest rates." Axilrod, FOMC Economist (MOD, 11/20/72, p.43)

A more direct route to optimistic views of interest rate effects is that projections of interest rates associated with alternative options were judgmentally adjusted by senior staff. Especially after staff models began to overpredict M_1 growth in the mid-1970s, there appear to have been nontrivial downward judgmental adjustments of interest rate changes associated with alternative money growth paths.

"Mr. Gramley said there was considerable uncertainty about the projections of interest rates, which were among the most difficult variables to project. As Committee members knew, the staff tended to make rather large judgmental adjustments to the interest rate projections produced by the model. In the latest projection,...the model had produced a short-term interest rate in the fourth quarter of 1976 that was 2-3/4 percentage points above the staff's judgementally projected rate." (MOD, 9/16/75, p.25)

[22]The full system interest rate elasticity of the money supply is necessarily greater than the interest rate elasticity of nominal output if the interest rate elasticity of money demand is also negative.

A second interpretation of the apparent passivity of policy is that increased uncertainty about properties of empirical money demand functions after the mid-1970s may have induced more cautious policy adjustments.

> "Mr. Volcker said he felt rather strongly that the right approach to policy today was to hold interest rates fairly steady....Mr. Axilrod's remarks, which he found stimulating and even persuasive, provided a further indication of how little was known about the short-run relationship between interest rates and the money supply." (MOD, 11/18/75, p.39).[23]

Finally, a third conjecture concerning the framing of policy choices is that differences in the underlying relationships and forecast horizons of the short-run policy options of the Bluebook and of the multiperiod predictions of the Greenbook may have made it difficult for FOMC deliberations to connect current policy decisions to longer-run predicted outcomes.[24]

> "Mr. MacLaury remarked that he was disturbed by what he perceived as a lack of clarity in the Committee's methodology. While the Committee now was publicly announcing its longer-term targets, he has less confidence than before in his understanding of the path by which these objectives were to be achieved....it seemed strange for the blue book to state that all of the three alternatives it presented were generally consistent with the 12-month ranges. He believed it made a difference whether the Committee embarked on the path indicated by the high alternative or on that indicated by the low alternative." (MOD, 5/20/75, p.59)

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[23] "The actual stock of money has been running well short of what either our quarterly or monthly money market models would have predicted for some time, given actual GNP and interest rates....given uncertainties with respect to the meaning of recent money supply behavior as well as still unresolved issues affecting the municipal market, the committee may wish to consider giving somewhat more weight than usual to money market conditions in framing its instructions." Axilrod, FOMC Economist (MOD, 11/18/75, pp.33-5).

[24] Judgemental adjustments of interest rates associated with alternative policy options, discussed earlier, were motivated not only by money demand forecast errors in the 1970s but also by differences among competing staff models, such as the monthly money market model used in Bluebook analyses and quarterly models used for Greenbook analyses. "Mr. Gramley replied that the staff's interest rate projections depended on the relationship between growth in money and growth in nominal GNP. Personal income was used only in the monthly model, because no better monthly indicators of aggregate expenditures was available....Mr. Axilrod remarked that recent work done by the Board's staff indicated that in the first year of recovery interest rate projections based on nominal GNP were too high while those based on personal income were too low. In making its interest rate projections for the blue book, the staff had taken those results into account." (MOD, 9/16/75, pp. 32-3) Consequently, it is not historically accurate to assume that all judgemental forecast adjustments were confined to intercept adjustments. Kalchbrenner and Tinsley (1977) discuss differences between policy use of auxiliary measurements and use of competing models.

5 A contrast with 1970s monetary policy in Germany

Perhaps the deeper flaw of FOMC intermediate targeting in the 1970s is that it obscured the ultimate objectives of policy by shifting the official gauge of policy performance from inflation and economic activity to the growth rate of the money supply. Thus, an additional shortcoming of US policy in the 1970s was to underestimate the role of longer-run inflation expectations in influencing decisions of the private sector.

This contrasts with Bundesbank policy in the 1970s, which published medium-term objectives for inflation along with annual money growth targets, Gerberding, Worms and Seitz (2004). As the Bundesbank missed its annual money growth target ranges about half of the time, vid. Schmid (1999), it seems plausible that the announced medium-term inflation goals were more useful references in helping to anchor longer-run inflation expectations of the private sector.[25]

The Bundesbank inflation target and two indicators of long-run inflation in Germany are shown in Fig. 4 for 1970-79. The inflation-based indicator of long-run inflation is a fixed-gain estimate of the mean of German CPI inflation, using $\bar{\pi}_t = (1-\gamma)\bar{\pi}_{t-1} + \gamma\pi_t$, where $\gamma = 0.015$.[26] The bond rate indicator provides a more direct measure of bond trader real-time perceptions of long-run inflation where the indicator is the forward rate in the last year of the 10-year government bond, less an adjustment for a constant term premium and real interest rate, $f_{10,t} - \theta$.[27]

Similar to the upward movement of the perceived US inflation target shown in Fig. 1, both indicators of long-run inflation for Germany in Fig. 4 rise in the first half of the 1970s. But unlike the US experience, both indicators in Fig. 4 reverse course and track relatively closely the announced inflation target of the Bundesbank in the last half of the 1970s. [28]

A similar recognition of the important role of longer-run inflation expectations

[25] Associations between money supply targeting performance and inflation are tenuous. As noted earlier, the FOMC satisfied the published M1 target ranges in two of the four years from 1975Q4-1979Q4 but missed published target ranges throughout the disinflation of 1979Q4-1983Q4, Broaddus and Goodfriend (1984).

[26] As shown in Kozicki and Tinsley (2001b), a monthly gain of $\gamma = 0.015$ provides a reasonable approximation of survey estimates of US long-run inflation expectations.

[27] The constant, θ, is selected so the average of $f_{10,t} - \theta$ equals the average long-run inflation of the ECB Survey of Professional Forecasters in the available survey sample, 1999Q1-2009Q1.

[28] As documented in Gurkaynak et al. (2006), long forward rates appear to be better anchored with the announcement of explicit inflation targets.

in shaping agent decisions was a frequent theme in the testimony and speeches of Volcker, following the October 1979 shift in policy. When defending the continuation of restrictive monetary policy in the early 1980s, even after a sharp fall in current inflation, Volcker noted that success would be achieved when long-term interest rates signalled a decline in long-term inflation expectations.

> "Nothing would please me more than for interest rates to decline....But, I also know that it would be shortsighted for the Federal Reserve to abandon a strong sense of discipline in monetary policy in an attempt to bring down interest rates....When long-term interest rates decline decisively, it will be an indication of an important change in attitudes about the prospects for the economy. One essential element in this process must be a widespread conviction that inflation will be contained in the long run." Volcker (1982).[29]

6 Concluding remarks

Recent studies, including Kozicki and Tinsley (2005), indicate that dynamic properties of empirical macro models are often more realistic if allowance is made for differences in perceptions among private and public agents regarding the central bank target for inflation. The current paper provides estimates of the effective FOMC target for inflation implied by empirical policy response functions, where the real-time conditioning information is based on Greenbook briefing forecasts presented before FOMC meetings from the 1970s through the late-1990s.

In contrast to the assumption of a fixed central bank inflation target, the effective inflation target constructions not only vary considerably over the sample but are substantially different from available survey information on the long-horizon inflation expectations of private sector agents.

Of two leading empirical interpretations of the Great Inflation, the "passive policy" description of Clarida, Gali, and Gertler (2000) is perhaps the most optimistic, as empirical analyses of historical U.S. monetary policy generally indicate stable policy responses to inflation have been maintained since the 1980s. The "natural rate error" description of Orphanides (2003, 2004) has a seductive appeal for central banks for it suggests that unlucky mistakes were made, but

[29] Additional extracts from FOMC transcripts, supporting the view that Volcker and other members of the FOMC after October 1979 referenced long-term bond rates as indicators of the level and uncertainty of private sector long-term inflation expectations, are reproduced in Goodfriend and King (2005).

carries also the pessimistic inference that these mistakes will likely occur in the future. The empirical evidence presented in section 3 indicates that monetary policy in the 1970s is better characterized by money growth intermediate targeting. This implies that FOMC errors in estimating natural rate gaps for output or the unemployment rate are largely irrelevant to explanations of the Great Inflation.

The empirical evidence in section 3 also supports the passive policy interpretation, as adjustments of the U.S. central bank policy rate in the 1970s were not sufficiently vigorous to result in stable responses to movements in inflation.[30] However, the passive policy interpretation is merely a description of unstable policy, not an explanation. A description of 1970s FOMC policy based on intermediate targeting of money supply growth offers a neglected search area for explanations of passive policy responses, such as the optimistic estimates of interest rate elasticities discussed in section 4.

Given the advantage of hindsight, there will always be mistakes in the execution of monetary policy, including errors in estimating current values of conditional equilibria or responses to policy instruments. An additional shortcoming of US monetary policy in the 1970s, noted in section 5, was to neglect the potential for publicly announced inflation targets to anchor the longer-run inflation expectations of the private sector. Although money growth targets were published in both the US and Germany in the second half of the 1970s, the Bundesbank also announced longer-run inflation goals. Whereas indicators of long-run inflation in the US continued to rise throughout the 1970s, indicators of long-run inflation in Germany reversed direction and closely tracked the Bundesbank inflation objective.

The relative inefficiencies of money growth intermediate targeting have been documented at length elsewhere, such as Rudebusch and Svensson (2002). Obviously, it does not diminish notable contributions of monetarism to the design of postwar monetary policy to acknowledge a causal role for money growth intermediate targeting during the Great Inflation of the U.S. Historical documentation in this paper supports the assessment of Milton Friedman (2006): “The use of the quantity of money as a target has not been a success.”

[30]Kozicki and Tinsley (2008) indicate passive policy rate responses to inflation may not be sufficient to rule out determinate inflation and present evidence that US bond rates had elastic responses to inflation in the 1970s.

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Table 1
Unpublished FOMC targets for M1 growth, 1970-1975

FOMC date	target (%)	FOMC date	target (%)
2/10/70	70Q1 4.0	1/16/73	73Q1-Q2 5.0-6.0
3/10/70	70Q2 3.0	2/13/73	73Q1-Q2 5.0-6.0
4/7/70	70Q2 3.0	3/20/73	73Q2-Q3 5.0-5.5
5/05/70	70Q2 4.0	4/17/73	73Q2-Q3 5.25
5/26/70	70Q2 4.0	5/15/73	73Q2-Q3 5.0-5.5
6/23/70	70Q3 4.0	6/19/73	73Q3-Q4 4.5
7/21/70	70Q3 5.0	7/17/73	74Q3-Q4 3.75
8/18/70	70Q4 5.0	8/21/73	73Q3-Q4 3.75
9/15/70	70Q4 5.0	9/18/73	73Q4-74Q1 4.5
10/10/70	70Q4 5.0	10/16/73	73Q4-74Q1 5.0
11/17/70	70Q4 4.0; 71Q1 6.0	11/20/73	73Q4-74Q1 5.0
12/15/70	71Q1 6.0	12/18/73	74Q1-Q2 5.25
1/10/71	71Q1 7.5	1/22/74	74Q1-Q2 5.75
2/9/71	71Q1 6	2/10/74	74Q1-Q2 5.75
3/9/71	71Q2 9.5	3/19/74	74Q2-Q3 5.25
4/6/71	71Q2 8.0	4/16/74	74Q2-Q3 5.5
5/11/71	71Q2 8.5; 71Q3 7.5	5/21/74	74Q2-Q3 5.5
6/8/71	71Q3 9.5	6/18/74	74Q3-Q4 5.25
6/29/71	71Q3 9.0	7/16/74	74Q3-Q4 5.25
7/27/71	71Q3 9.0; 71Q4 4.0	8/20/74	74Q3-Q4 5.25
8/24/71	71Q3 8.0; 71Q4 3.0	9/10/74	74Q4-75Q1 5.75
9/21/71	71Q4 3.5-4.5; 71Q3-Q4 4.0-4.5	10/15/74	74Sept-75Jun 5.75
10/19/71	71Q4 2.5; 72Q1 4.5	11/19/74	74Sept-75Jun 5.75
11/16/71	71Q4 0.0; 72Q1 6.0	12/17/74	74Dec-75Jun 6.0
12/14/71	72Q1 7.0		
1/10/72	72Q1 7-8	1/21/75	75Q1-Q2 6.0
2/15/72	72Q1 7-8	2/19/75	74Dec-75Jun 4.5
3/21/72	72Q2 7.5		74Dec-75Sept 6.0
4/17/72	72Q2 7.25		74Jun-75Jun 3.75
5/23/72	72Q2 7.25; 72Q3 6.5	3/18/75	74Dec-75Jun 4.5
6/19/72	72Q3 6.5		74Dec-75Sept 6.0
7/18/72	72Q3 6.5		74Jun-75Jun 3.75
8/15/72	72Q4 7.5; 72Q4-73Q1 6.7	4/15/75	75Mar-76Mar 5.0-7.5
9/19/72	72Q4 7.5; 73Q1 6.5		
10/17/72	72Q4-73Q1 6.0		
11/21/72	72Q4-73Q1 6.0		
12/19/72	73Q1-Q2 5.0-6.0		

Sources: FOMC *Memorandum of Discussion* and *Bluebook*. Published targets began in May 1975.

Table 2
Subscript notation and examples

item	notation	comment
FOMC meeting date	t_f	within quarter t
Greenbook (GB) date	t_g	within quarter t, prior to t_f
Federal funds rate	r_{t_f}	meeting-to-meeting average, from t_f to $t_f + 1$
GB forecast of variable z_t	$z_{t\|t_g}$	forecast in t_g of z in current quarter t
GB forecast of variable z_{t+1}	$z_{t+1\|t_g}$	forecast in t_g of z in next quarter of forecast horizon

Table 3
Federal funds rate policy rule: Burns/Miller and Volcker/Greenspan samples

$$
\begin{aligned}
r^*_{t_f} &= \bar{\rho}_t + \bar{\pi}_t + c_{2,t}(\pi^4_{t+1|t_g} - \bar{\pi}_t) + c_{3,t}(u_{t+1|t_g} - \bar{u}_t) + c_{4,t}\Delta u_{t|t_g}, \\
r_{t_f} &= (1-\beta_{6,t})r^*_{t_f} + \beta_{5,t}\Delta r_{t_f-1} + \beta_{6,t} r_{t_f-1} + a_{t_f}, \\
&= \beta_{1,t} + \beta_{2,t}\pi^4_{t+1|t_g} + \beta_{3,t}(u_{t+1|t_g} - \bar{u}_t) + \beta_{4,t}\Delta u_{t|t_g} + \beta_{5,t}\Delta r_{t_f-1} + \beta_{6,t}(r_{t_f-1} - \bar{\rho}_t) + \bar{\rho}_t + a_{t_f}, \\
\bar{\pi}_t &= -\beta_{1,t}/(\beta_{2,t} + \beta_{6,t} - 1).
\end{aligned}
$$

tvp format		estimated β_i						estimated $\bar{\pi}_t$	
		Burns/Miller sample: 1970Q1-1979Q2							
		$\bar{\beta}_1$	$\bar{\beta}_2$	$\bar{\beta}_3$	$\bar{\beta}_4$	$\bar{\beta}_5$	$\bar{\beta}_6$	min	max
RWI	mean coeff	.025	.116	-.067	-.229	.532	.893	-3.7	-0.1
	p-value	[.60]	[.01]	[.09]	[.03]	[.00]	[.00]		
SC	mean coeff	.017	.120	-.066	-.242	.523	.891	-9.0	1.1
	p-value	[.90]	[.01]	[.11]	[.03]	[.00]	[.00]		
	(var decomp %)	17	42	1	0	0	40		
		Volcker/Greenspan sample: 1979Q3-1997Q4							
		$\bar{\beta}_1$	$\bar{\beta}_2$	$\bar{\beta}_3$	$\bar{\beta}_4$	$\bar{\beta}_5$	$\bar{\beta}_6$	min	max
RWI	mean coeff	-.159	.222	-.073	-.296	.364	.833	2.2	3.5
	p-value	[.05]	[.00]	[.01]	[.01]	[.00]	[.00]		
SC	mean coeff	-.154	.229	-.066	-.286	.406	.819	3.1	3.4
	p-value	[.20]	[.02]	[.03]	[.09]	[.00]	[.00]		
	(var decomp %)	5	58	0	0	0	37		

r_{t_f} denotes the average funds rate from the FOMC meeting t_f, within quarter t, to the next FOMC meeting; $\pi^4_{t+1|t_g}$ is 4-quarter inflation and $u_{t+1|t_g} - \bar{u}_t$ is the unemployment deviation from the unemployment natural rate, drawn from the multiperiod Greenbook (GB) forecast t_g, prior to FOMC meeting t_f. Estimates of GB natural rates, $\bar{u}_t$, are discussed in Kozicki and Tinsley (2006). As noted in text, the time-varying coefficient specifications are random walk intercept (RWI) and stationary coefficients (SC).

Table 4
Federal funds rate policy rule Burns/Miller sample: money growth targeting

$$
\begin{aligned}
r^*_{t_f} &= \bar{\rho}_t + \bar{\pi}_t + c_{2,t}\Delta x_{t+1|t_g} + c_{3,t}(u_{t+1|t_g} - \bar{u}_t) + c_{4,t}\Delta u^4_{t+1|t_g}, \\
\Delta x_{t+1|t_g} &= \pi^4_{t+1|t_g} - \bar{\pi}_t - a'\Delta u^4_{t+1|t_g}, \\
r_{t_f} &= (1-\beta_{6,t})r^*_{t_f} + \beta_{5,t}\Delta r_{t_f-1} + \beta_{6,t} r_{t_f-1} + a_{t_f}, \\
&= \beta_{1,t} + \beta_{2,t}\Delta x_{t+1|t_g} + \beta_{3,t}(u_{t+1|t_g} - \bar{u}_t) + \beta_{4,t}\Delta u^4_{t+1|t_g} + \beta_{5,t}\Delta r_{t_f-1} \\
&\quad +\beta_{6,t}(r_{t_f-1} - \bar{\rho}_t) + \bar{\rho}_t + a_{t_f}, \\
\bar{\pi}_t &= -\beta_{1,t}/(\beta_{2,t} + \beta_{6,t} - 1).
\end{aligned}
$$

tvp format		estimated β_i						estimated $\bar{\pi}_t$	
		β_1	β_2	β_3	β_4	β_5	β_6	min	max
RWI	mean coeff	.156	.037	-.008		.518	.942	6.3	7.5
	p-value	[.00]	[.03]	[.80]		[.00]	[.00]		
SC	mean coeff	.149	.040	-.009		.509	.940	6.8	7.8
	p-value	[.21]	[.02]	[.78]		[.00]	[.00]		
	(var decomp %)	30	11	2		0	56		
RWI	mean coeff	.024	.093		.114	.557	.906	9.4	27.1
	p-value	[.61]	[.02]		[.12]	[.00]	[.00]		
SC	mean coeff	.037	.092		.114	.545	.904	7.4	118
	p-value	[.78]	[.02]		[.13]	[.00]	[.00]		
	(var decomp %)	16	33		0	0	51		
RWI	mean coeff	.146	.037			.523	.941	6.1	7.1
	p-value	[.00]	[.03]			[.00]	[.00]		
SC	mean coeff	.142	.038			.515	.940	6.5	7.2
	p-value	[.21]	[.02]			[.00]	[.00]		
	(var decomp %)	32	10			0	58		

Sample 1970Q1-1979Q2; r_{t_f} denotes the average federal funds rate from FOMC meeting t_f, within quarter t, to the next FOMC meeting; $\pi^4_{t+1|t_g}$ and $\Delta u^4_{t+1|t_g}$ are 4-quarter GB forecasts from the multiperiod GB forecast t_g, prior to FOMC meeting t_f. The Okun's Law assumption, $a' = 2.2$, is drawn from Tatom (1978). As noted in text, the time-varying coefficient specifications are random walk intercept (RWI) and stationary coefficients (SC).

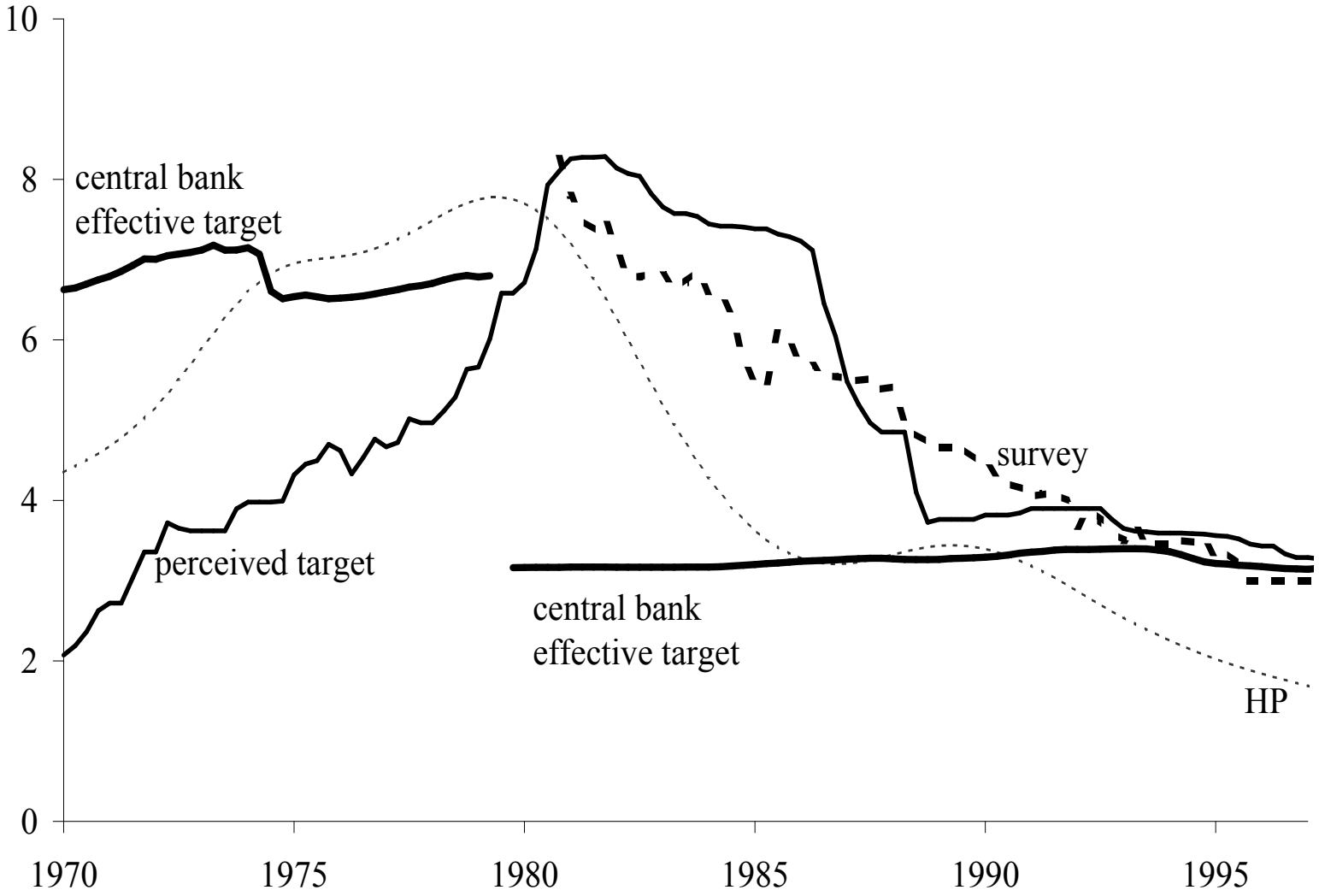

Fig. 1. Historical and perceived FOMC inflation targets, 1970-1997. The "effective targets" are implied by stationary coefficient (SC) specifications, from the bottom panel of Table 4 for Burns/Miller sample and bottom panel of Table 3 for Volker/Greenspan sample. The "perceived target" denotes private sector perceptions from Kozicki and Tinsley (2001a); "survey" denotes the Hoey survey of 5-10 year expected inflation; and "HP" denotes a Hodrick-Prescott filter of real-time inflation.

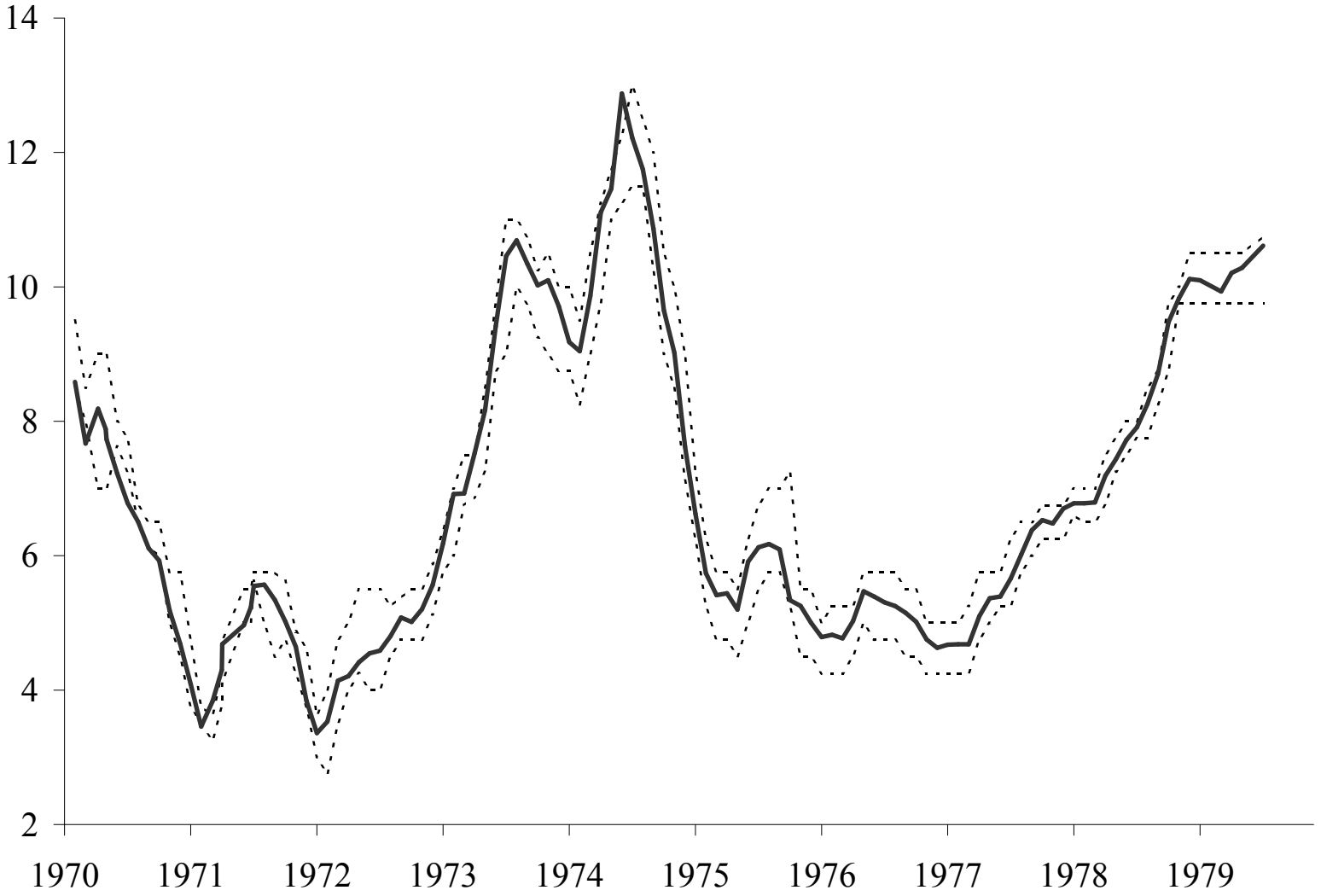

Fig. 2. Federal funds rate and FOMC tolerance ranges, Burns/Miller tenures.

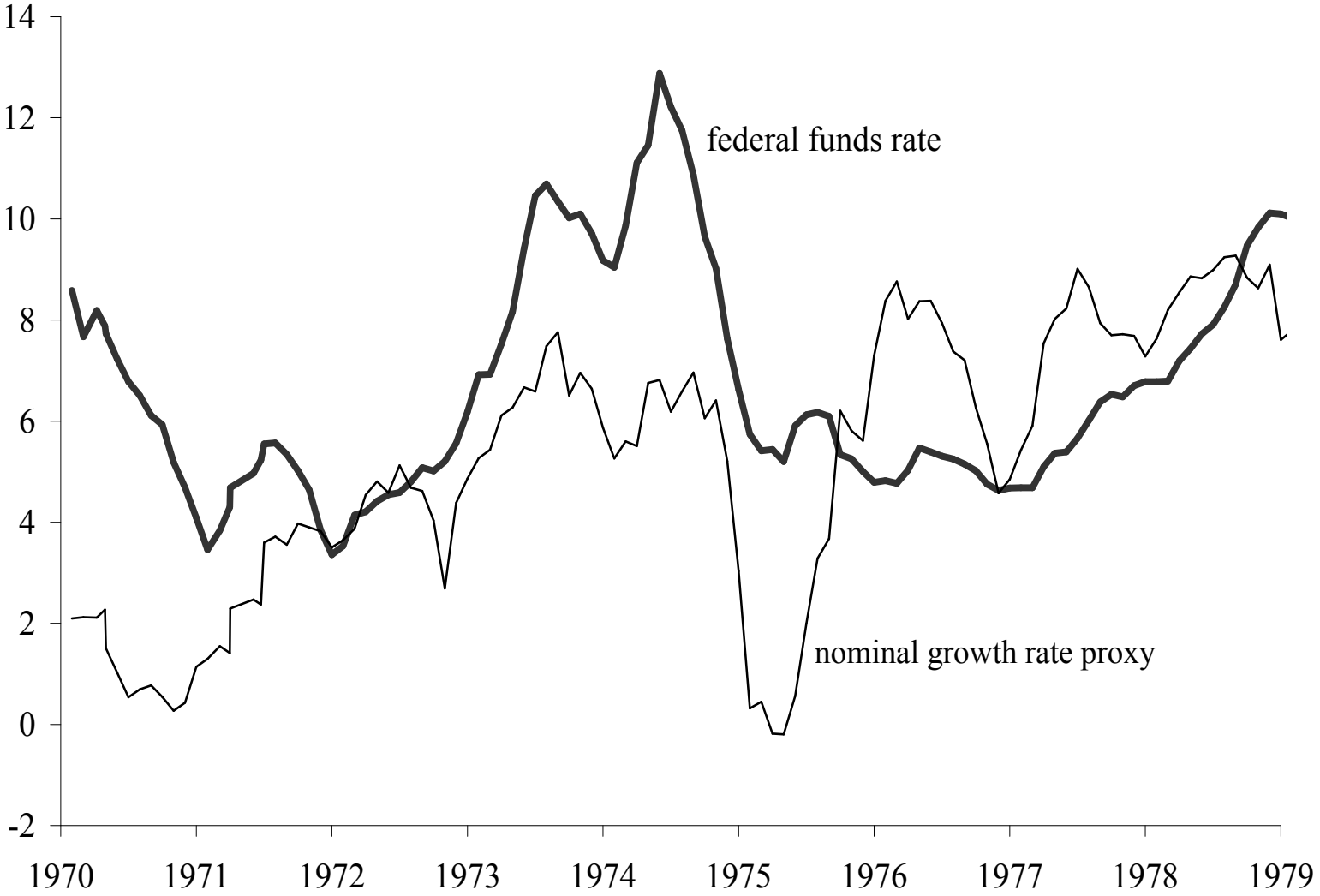

Fig. 3. Federal funds rate and the predicted nominal growth proxy, Burns/Miller tenures. The proxy for 4-quarter growth rates of nominal GDP is based on Greenbook predictions of inflation and unemployment and defined by $\Delta x_{t+1|t_g}$ in Table 4.

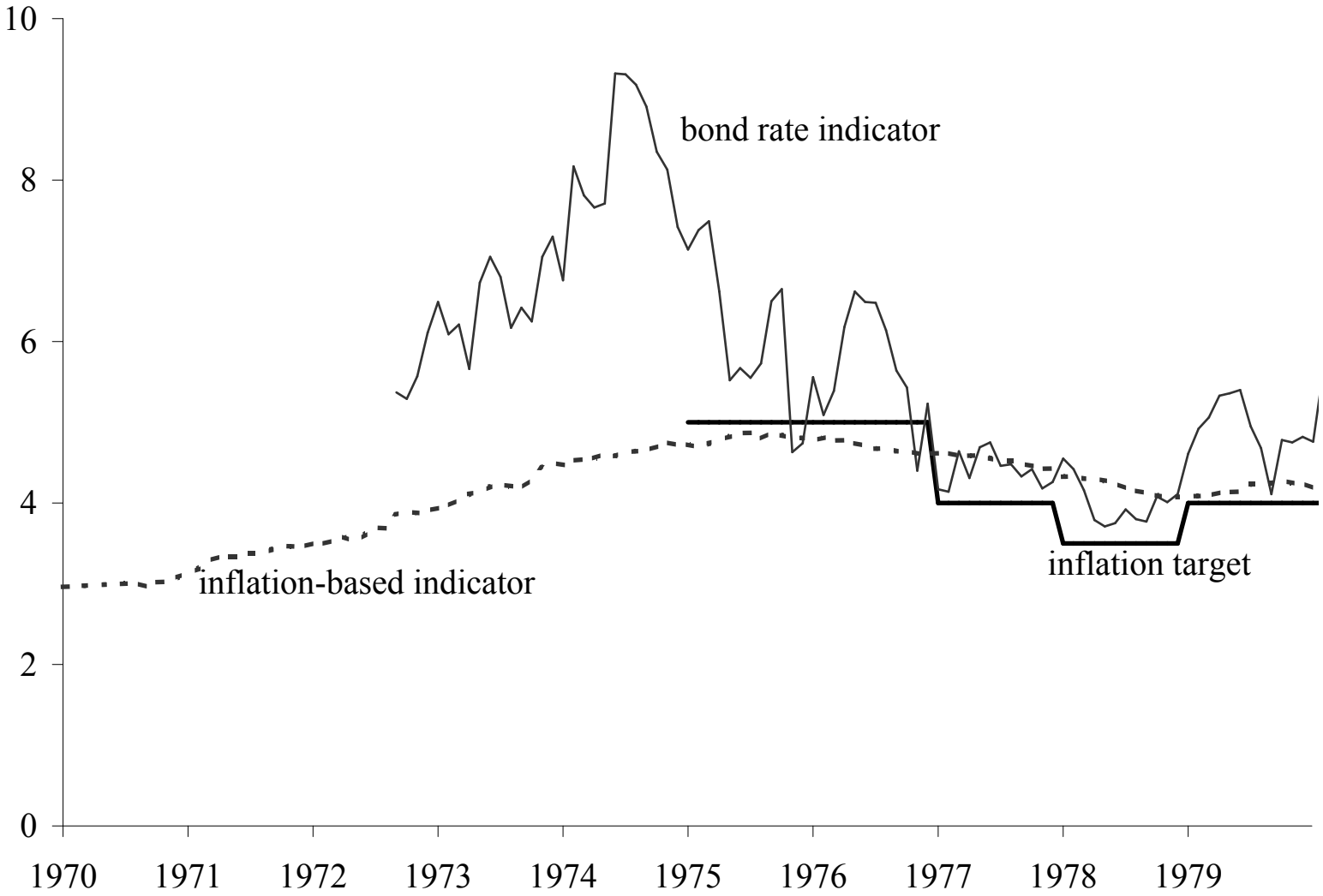

Fig. 4. Bundesbank inflation target and long-term inflation indicators, 1970m1-1979m12. The inflation target is from Gerberding et al. (2004). The inflation-based indicator of long-term inflation is a fixed-gain estimate of mean German CPI inflation, using a monthly gain of 0.015. The bond rate indicator of long-term inflation is the forward rate in the last year of the government 10-year bond, adjusted for a constant real interest rate and term premium, as discussed in the text.