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How Would Have Monetary Policy During the Great Inflation Differed, if it Had Been Conducted in the Styles of Volcker and Greenspan and with Perfect Foresight?

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Using nonlinear monetary policy rules estimated under Martin, Burns/Miller, Volcker and Greenspan chairmanships this paper evaluates quantitatively how monetary policy under Burns/Miller would have differed, if it had been conducted by means of the policy rules found for each of the other three chairs. The main results are that if policy had been conducted by means of a Volcker-type rule, it would have been uniformly more restrictive; and if it had been conducted by means of a Greenspan-type rule, it would have been less restrictive. These results are robust to the introduction of real-time data. The paper also evaluates the impact of inflation uncertainty on monetary policy. Real-time Greenbook inflation forecasts reveal that, during the great inflation period, the Fed's staff believed that monetary policy was more restrictive than it turned out to be with the benefit of hindsight. The opposite happened during inflation stabilization under Volcker.
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INTRODUCTION

The great inflation of the 1970s and its aftermath under Volcker is one of the most traumatic events of US economic history during the second half of the twentieth century. Many explanations have been offered for the rise and fall

of that inflation. Among those are initially faulty models of the economy, political pressures, limited independence of the Federal Reserve, direct inflationary impacts of the two oil shocks, the breakdown of the Bretton-Woods System at the beginning of the 1970s, large and persistent underestimation of potential output by policymakers at the Fed and overexpansionary fiscal policy.

During the 15 years between the early 1950s and the mid-1960s the US enjoyed virtual price stability. Over this period consumer price index (CPI) inflation seldom exceeded 2% and was normally between 0% and 2%. With the intensification of the military buildup in Vietnam during the second half of the 1960s, CPI inflation gradually increased reaching over 6% during the last quarter of the 1960s. Following the imposition of price controls inflation partially slowed back to the 3% to 4% range during the early 1970s but shot up dramatically following the first oil shock in 1973. It accelerated to almost 10% in the last quarter of 1973, and fluctuated above this figure throughout 1974 reaching over 12% in the last quarter of that year. Inflation receded to the 5% to 9% range between 1975 and 1978 but accelerated again following the second oil shock reaching a peak over 15% at the beginning of 1980.

After almost 20 years as Chairman of the Federal Reserve Board William McC. Martin was replaced by Arthur Burns during the first quarter of 1970. Burns was succeeded in 1978 by G. William Miller for about a year and Miller was replaced by Paul Volcker during the third quarter of 1979. Together, Burns and Miller presided over the decade of the 1970s that was characterized by the highest and most persistent inflation the US had experienced during the twentieth century. During his term, which ended in 1987, Volcker managed to finally stabilize inflation at great costs in terms of output. Alan Greenspan who succeeded him inherited a relatively stable economy allowing him to pay relatively more attention to the stabilization of output.

Although different economists may differ on the relative importance of the contribution of different factors to the great inflation there is, I believe, a broad consensus regarding the following statements. First, long run structural changes in the Fed's objectives and policy rule were important factors both in the rise and fall of the great inflation. Second, the evolution of inflationary expectations played an important role in the propagation of the great inflation and their behavior under Volcker was an important reason for the pain and time required to restore the price stability of the 1950s and of the early 1960s.

This paper provides direct empirical evidence on the implicit policy rule followed during the Burns/Miller great inflation period and compares it to the implicit rules followed during Volcker's disinflation and under Greenspan's and Martin's tenure as chair. In particular, it examines how monetary policy during the 1970s would have differed if conducted by means of those alternative policy rules. Those counterfactual experiments take the policy

rules followed under the different chairs as *given*. The broader, Lucas critique-type question, concerning the impact of the state of the economy on the nature of policy rules is beyond the scope of these counterfactuals. Nonetheless, their results are consistent with the view that policy rules adapt, at least to some extent, to major changes in economic conditions.[1] The paper also provides evidence on unexpected inflation and on the impact of inflation uncertainty on evaluation of the real monetary policy stance by the Fed's staff during the great inflation and its aftermath.

The paper is organized as follows. The first part of section 'How would have interest rate decisions in the 1970s differed if taken by means of Volcker's, Greenspan's and Martin's policy rules?' utilizes nonlinear interest rate rules for the Burns/Miller, Volcker, Greenspan and Martin chairmanships (estimated in Cukierman and Muscatelli, 2008) to examine how monetary policy during the 1970s would have differed if conducted by means of each of those alternative policy rules. With a new Keynesian economy a concave rule is indicative of dominant recession avoidance preferences (RAP) at the Fed and a convex rule is indicative of dominant inflation avoidance preferences (IAP).[2] The main results are: (1) If policy during the 1970s had been conducted by means of Volcker's rule, it would have been *more* restrictive during most of that decade. (2) If it had been conducted by Greenspan's rule, it would have been *less* restrictive for most of the decade. (3) If it had been conducted under a Martin policy rule, it would have been substantially and *more persistently restrictive* after the first oil shock.

In a series of papers Orphanides convincingly argues that Fed's perceptions of the output gap were substantially biased downward during the 1970s (eg Orphanides, 2001). It is therefore possible that the RAP detected in Cukierman and Muscatelli for the Burns/Miller era is due to the fact that they had used retrospective, rather than real time, data to measure the output gap. To examine the robustness of the results to this potential problem the counterfactual experiments from the first part are repeated with linear interest rules estimated with real-time data in the last part of section 'How would have interest rate decisions in the 1970s differed if taken by means of Volcker's, Greenspan's and Martin's policy rules?' The main conclusion is that results 1 and 2 above stand and are even amplified.[3]

[1] A further elaboration appears in the concluding section.

[2] RAP means that policymakers are more averse to negative than to positive output gaps. IAP means that they are more averse to positive than to negative inflation gaps. Here, the inflation gap is defined as the deviation of inflation from it implicit target. Details appear in Cukierman and Muscatelli (2008).

[3] The absence of real-time data for Martin's era precluded the reexamination of this period with this type of data.

Section 'Inflationary expectations and the great inflation' examines the extent to which monetary policy under Burns/Miller, Volcker and the early Greenspan years might have been affected by inflation forecast errors. Using data on inflation forecasts from the federal open market committee (FOMC) Greenbook (GB) and on private sector inflationary expectations from the Survey of Professional Forecasters (SPF) and the Livingston Survey (LS), the section shows that, for the most part, inflation was universally underestimated during the 1970s and overestimated during the credibility rebuilding period under Volcker. In particular, underestimation of inflation during the Burns/Miller period implies that the Fed's monetary policy stance as derived from the GB forecasts must have systematically considered the policy stance of the Fed to be more restrictive than what it turned out to be with hindsight. Or, in different words, *ex ante* real interest rates were largely considered by the Fed's staff to be higher than their realized *ex post* counterparts. It is therefore likely that the great inflation of the 1970s was reinforced by the Fed's overestimation of real interest rates. The section also demonstrates that inflation uncertainty, which was abnormally high by long-term US standards under Burns/Miller and Volcker, decreased substantially during Greenspan's term in office. This is followed by concluding reflections.

HOW WOULD HAVE INTEREST RATE DECISIONS IN THE 1970s DIFFERED IF TAKEN BY MEANS OF VOLCKER'S, GREENSPAN'S AND MARTIN'S POLICY RULES?

With retrospection, it is generally felt that one of the reasons for the magnitude and persistence of the great inflation was that monetary policy during the Burns/Miller era was too loose. One way to evaluate whether this is the case, and if so, how strong was this inclination towards monetary permissiveness is to compare the path of the policy rate, and the closely related federal funds rate (FFR), under Burns and Miller to the paths that these rates would have followed had policy been conducted in the styles of other Fed chairs. As is well known, Burns and Miller were succeeded by a relatively restrictive monetary policy under Volcker, which ultimately brought inflation down. By the time Greenspan replaced Volcker in the third quarter of 1987, CPI inflation had come down from the double-digit range at the beginning of Volcker's term to the vicinity of 4%. Under Greenspan inflation went down even further. It is therefore interesting to examine how monetary policy during the 1970s would have differed, had it been conducted in the styles of Volcker and Greenspan. For completeness the paper also examines how policy during the 1970s would have differed if it had been conducted in

the style of Martin who preceded Burns as chair. Most of Martin's term was characterized by inflation rates, which are commonly considered as price stability. But during his last several years in office, between 1966 and 1969, inflation accelerated reaching a peak at the beginning of 1970 when his term as chair ran out.

Counterfactuals based on nonlinear Taylor rules and retrospective data

To conduct counterfactual experiments of the type described above it is necessary to have in hand operational characterizations of different policy-making 'styles'. Here I use Taylor rules estimated in Cukierman and Muscatelli (2008) (CM in the sequel) for each of the following periods at the Fed; Martin, Burns/Miller, Volcker and Greenspan to precisely characterize the policy style under each chair.[4] The estimated rules relate, as in Clarida *et al*. (2000) (CGG-00), the FFR to policymakers' expectation of upcoming values of the inflation and output gaps and to the lagged value of the policy rate with one important difference. The specification used allows for potential nonlinearities in the reaction functions by using hyperbolic tangent smooth transition regressions (HTSTR). As explained in CM, the functional form conveniently maps the convexity or concavity properties of the reaction function with respect to the output and inflation gaps into two parameters denoted by β_2 and γ_2, respectively.[5] In particular, it implies that, depending on whether β_2 is positive or negative, the reaction function is convex or concave with respect to the inflation gap, and depending on whether γ_2 is positive or negative the reaction function is concave or convex with respect to the output gap. When $\beta_2 = \gamma_2 = 0$ the Taylor rule is linear and reduces to the specification in CGG-00. The linear coefficients of the inflation gap, the output gap, the lagged interest rate and the regression constant are denoted by β_1, γ_1, ρ and α, respectively.

Table 1 shows that the curvature properties of the reaction function has varied across different chairs. In particular, during the Burns/Miller and Greenspan periods the coefficient estimates indicate that the reaction functions are mostly concave while under Volcker the Taylor rule is linear and under Martin it is convex. In general, nonlinear Taylor rules imply that the underlying loss function of policymakers is not quadratic in either the

[4] Burns and Miller are lumped into a single period since the term of the latter was rather short and he did not have much time to develop a style of his own.

[5] The estimated nonlinear policy rule is $i_t = (1-\rho)\{\hat{\alpha} + \beta_1\pi_t + \gamma_1 x_t + \beta_2(\pi_t - \pi^*)\tanh[\psi_\pi(\pi_t - \pi^*)] + \gamma_2 x_t \tanh[\psi_x x_t]\} + \rho i_{t-1}$. Here i_t,π_t,x_t and π^* are the federal funds rate, inflation, the output gap and the implicit inflation target, respectively. tanh stands for the hyperbolic tangent. The implicit inflation target and all remaining symbols denote estimated parameters. A convenient feature of the HTSTR is that it make it possible to estimate the implicit inflation target, π^*.

Table 1: Reaction functions by board chairs: US, 1960:1–2005:4

Period	Estimated coefficients							Stats
	$\hat{\hat{\alpha}}$ or $\hat{\hat{\alpha}}$	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\gamma}_1$	$\hat{\gamma}_2$	$\hat{\rho}$	π^*	
Martin								
1960:1	5.76**	−1.80*	3.21**	0.34**	0.09**	0.76**	1.3	σ=0.42
1970:1	(1.52)	(0.98)	(0.63)	(0.17)	(0.04)	(0.08)		J_{15}=11.6
Burns/Miller								
1970:2	1.42**	0.86**	0.08	0.55**	−0.90**	0.42**	3.2	σ=0.85
1979:3	(0.72)	(0.09)	(0.72)	(0.19)	(0.45)	(0.13)		J_{15}=14.0
Volcker								
1982:4	0.16	1.52**	—	0.80**	—	0.89**	—	σ=0.84
1987:3	(1.31)	(0.29)		(0.40)		(0.03)		J_{17}=11.6
Greenspan								
1987:4	2.35	1.01**	−0.92	0.88**	−0.84**	0.81**	2.9	σ=0.38
2005:4	(1.08)	(0.36)	(0.85)	(0.12)	(0.14)	(0.03)		J_{15}=13.4

Note: Numbers in parentheses indicate standard errors; σ indicates the standard error of the estimate; J_n is Hansen's test of the model's overidentifying restrictions, which is distributed as a $\chi^2(n+1)$ variate under the null hypothesis of valid overidentifying restrictions. Two stars designate a coefficient/statistic that is significant at the 5% level, and one star indicates significance at the 10% level. The interest rate, the output gap, inflation, the inflation target, π^*, and σ are all measured in percentages.
Source: Cukierman and Muscatelli (2008), Table 2.

inflation gap or in the output gap, or in both. CM show that, given a New-Keynesian economy of the type presented in Clarida *et al.* (1999) (CGG-99 in the sequel), concavity of the reaction function with respect to both gaps indicates that policymakers' preferences are dominated by stronger aversion to negative than to positive output gaps and convexity of the reaction function indicates that their preferences are dominated by stronger aversion to positive than to negative inflation gaps (Proposition 1 in CM). Using their terminology I refer to these two types of asymmetry as RAP and IAP, respectively.[6] Thus, given a CGG-99 New Keynesian framework, the results in Table 1 are consistent with the view that RAP dominated under Burns/Miller and Greenspan, IAP dominated under Martin and that under Volcker the more prevalent recession avoidance of the Fed was offset by inflation avoidance.

[6] In the presence of RAP only, theory implies that the reaction function is concave and in the presence of IAP only it is convex. When both asymmetries are present the reaction function may still be linear since each of RAP and IAP move the benchmark Taylor rule away from linearity in opposite directions.

Evidence supporting dominant RAP during the 1970s[7]

The notion that losses from the output and inflation gaps are subject to asymmetries actually goes back to the 1970s. At the time, the staff of the Fed used the following loss function to evaluate the impact of alternative policy choices by means of various large-scale econometric models including the Fed's own MIT-Penn-SSRC (MPS) model (Craine *et al.*, 1978, equation 1)

$$L = \sum_{i=1}^{h} \Big\{ 2(u_i > 4.8)^2 + (\pi_i > 2.5)^2 + 5(|\Delta r_i^{TB}| > 1.5)^2 + 0.00001 LM1G \Big\} \tag{1}$$

where u_i, π_i are the rate of unemployment and the rate of inflation in quarter i in the future and Δr_i^{TB} is the change in the treasury bill rate between period i and period $i-1$. $LM1G$ is a quadratic in the rate of change in the rate of growth of narrow money from a 5.1% benchmark. The target values for inflation (2.5%) and unemployment (4.8%) were chosen based on the Nixon administration announced 1973 inflation and unemployment objectives in conjunction with the long run rate of unemployment implied by the MPS model. As is well known, forecasts derived from the MPS model were rather poor. But this fact is orthogonal to the features of the loss function in (1) which is the main focus of the following argument. In particular, this loss function only penalizes *positive* deviations of unemployment from its natural level and *positive* deviations of inflation from the 2.5% target. In other words *it builds in both RAP and IAP*. This loss function was used by the staff of the Fed when presenting the consequences of alternative policy decisions to the Board. Although there is no evidence that the Board officially endorsed this loss function it is reasonable to presume that the staff would not have proposed it, if it had not been in the ballpark of the implicit objectives of the Board and the FOMC at the time. It is also noteworthy that the weight on deviations of unemployment from the target is twice the size of the weight on deviations of inflation from its target. This in conjunction with the concavity of the Taylor rule under Burns shown in Table 1 above is consistent with the view that, to the extent that decision making under Burns had been subject to IAP, the reaction function was dominated by recession avoidance.

Counterfactual paths of the FFR during the 1970s

The graphs in Figures 1 (a)–(c) show what would have been the paths of the FFR during the period corresponding to the Burns/Miller tenure (essentially

[7] Athanasios Orphanides brought the evidence in this subsubsection to my attention.

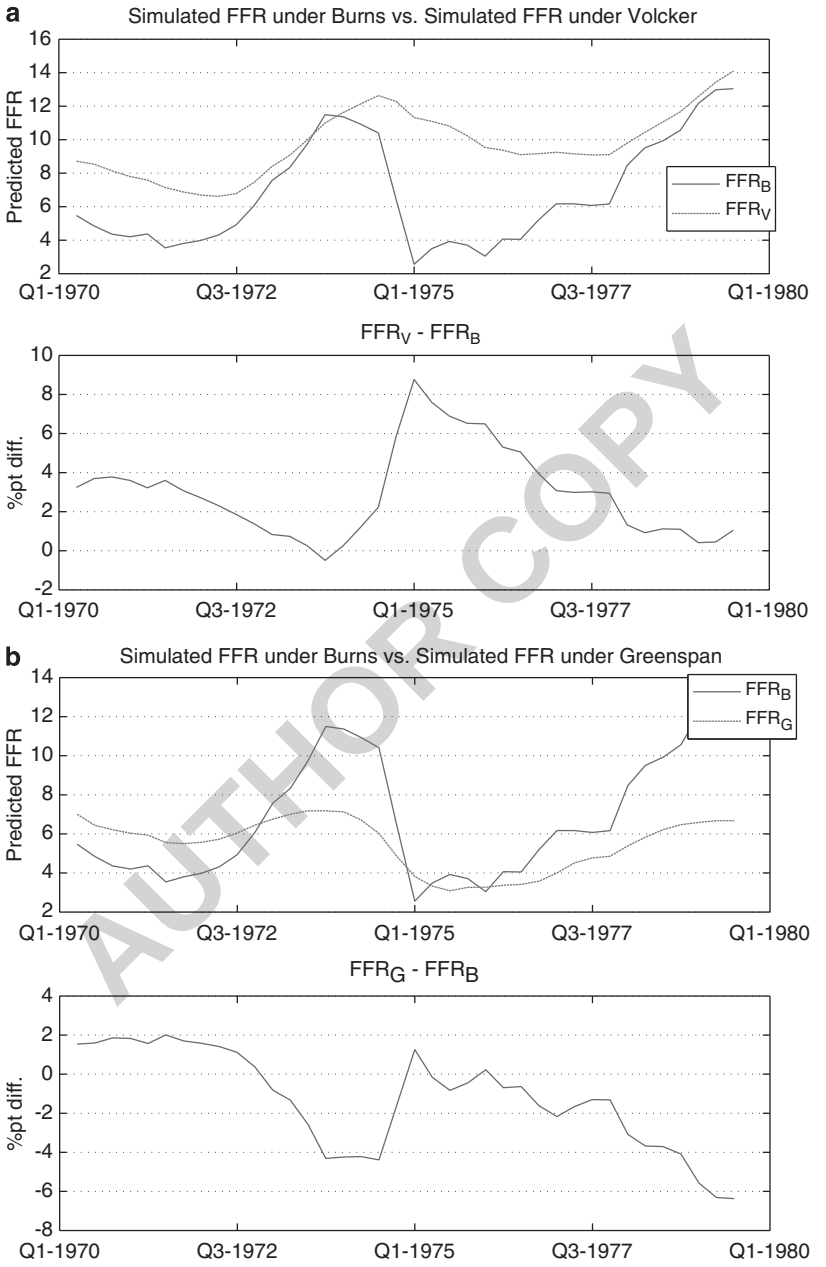

Figure 1: Counterfactual federal funds rates based on retrospective data estimates. (a) Counterfactual based on nonlinear Taylor rule – Volcker; (b) Counterfactual based on nonlinear Taylor rule – Greenspan; (c) Counterfactual based on nonlinear Taylor rule – Martin.

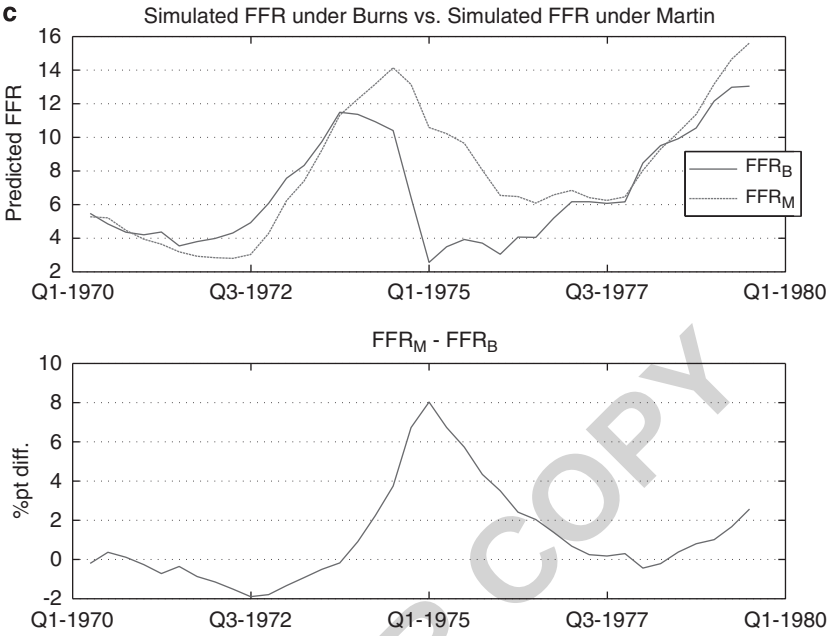

Figure 1: *Continued.*

the 1970s) had policy been conducted in line with the nonlinear policy rules estimated in Table 1 for each of the other chairs. In each case the value of the federal fund rate predicted by Burns' nonlinear rule in Table 1 (FFR_B) is presented for comparison purposes with the paths simulated by using the Taylor rules of Volcker (FFR_V), Greenspan (FFR_G) and Martin (FFR_M). This is shown in the first panel of each figure. The simulations are all dynamic in the sense that they take into consideration the slow adjustment of the policy rate. In all cases the initial value of the FFR for starting the simulations is equal to its actual value in the quarter immediately preceding the beginning of Burns' term in office (70:1). The second panel in each figure shows the difference between the value of the FFR predicted by using the counterfactuals (FFR_V, FFR_G or FFR_M) and between the rate predicted by the Taylor rule under Burns.

The main lessons from the counterfactuals follow. Not surprisingly, if policy during the 1970s had been conducted by a Volcker type, the path of the FFR would have been uniformly higher. This is particularly striking after the first oil shock and to a lesser extent during the first 3 years of Burns' tenure as chair (Figure 1 (a)). More surprisingly, policy under a Greenspan-type policy would have been more expansionary than under Burns during most of the

1970s (Figure 1 (b)). This is particularly in evidence during the two oil shocks. Those findings are consistent with the view that reaction functions adapt to the economic environment. Volcker who inherited a highly inflationary environment tightened rates sharply. On the other hand under Greenspan, whose term started after inflation had been largely conquered, recession avoidance became sufficiently important to make his policy, given similar circumstances, even looser than that of Burns/Miller. Finally, although during most of the 1970s, a Martin-type approach to policy would have exerted a level of tightness similar to that of Burns, he would have responded substantially more aggressively than Burns to the first oil shock. This is consistent with a recent account by Wood (2005, p. 256) who notes that after the 1957–1958 recession, in response to criticism of insufficient ease before the House Ways and Means Committee, Martin said: 'I do want to point out that in 8 years of experience in the Federal Reserve System, I am convinced that our bias, if anything, has been on the side of too much money rather than too little'.

Anecdotal evidence about political pressures on burns

The Volcker and Greenspan counterfactuals are consistent with the view that at least part of the inflation of the 1970s and its persistence were due to the relatively soft policy stance adopted under Burns. This begs the question of whether this was due to incompetence or to lack of independence from political authorities. Leaving the competence issue aside for the time, there is evidence that political pressures were definitely part of the story. Vivid illustrations of such pressures appear in a summary of conversations between President Nixon and Burns in recently released Nixon tapes. For example, following Burns' warning about excessive liquidity during an October 1971 conversation in the Oval Office, Nixon responds by stating that the liquidity problem is 'just bullshit' (Abrams, 2006, p. 180). To resist such pressures Burns and the FOMC would have needed stronger professional convictions and backing about the urgency of restrictive policies than those they could hold in light of the state of academic economics of the time. As is well known, the decade of the 1970s was characterized by violent conceptual and policy differences between Keynesians and monetarists. Burns and the FOMC were often criticized for opposing reasons by those two camps. In his memoirs, Burns succinctly summarizes the inaction this injected into policymaking at the Fed by recalling that when one camp criticized the Fed's policy for not going sufficiently in a particular direction while critics in the other camp assailed him for doing too much of it, he safely ducked in the middle. Chapter 4 of Meltzer (2009) contains a detailed discussion of these and related issues.

Table 2: Real-time linear reaction functions: Burns, Volcker and Greenspan

Period	Estimated coefficients				
	$\hat{\alpha}$	$\hat{\beta}_1$	$\hat{\gamma}_1$	$\hat{\rho}$	$\overline{R^2}$
Burns/Miller (70:2–79:3)	3.20* (1.54)	1.40*** (0.26)	0.55*** (0.14)	0.62 0.09***	0.88
Volcker L (79:4–87:3)	4.56 (2.46)	1.50*** (0.35)	0.18 (0.31)	0.60 0.13***	0.81
Volcker S (82:4–87:3)	3.82 (2.31)	1.17 (0.77)	−0.10 (0.19)	0.62 0.20**	0.77
Greenspan (87:4–95:4)	3.81** (1.10)	1.11** 0.31	1.15*** (0.16)	0.73*** (0.04)	0.98

Note: Numbers in parentheses indicate standard errors.
*indicates significance at the 0.05 level; **indicates significance at the 0.01 level; ***indicates significance at the 0.001 level.

Counterfactuals based on real-time data and linear reaction functions

As noted earlier Orphanides (2001, 2004) convincingly argues that part of the inflation of the 1970s was due to substantial and persistent overestimation of potential output. Since the counterfactual experiments in the previous subsection are based on regressions estimated with retrospective, rather than with real-time data, it is desirable to reproduce them with real-time data for reasons of robustness. To this end I estimated linear Taylor rules with real-time data from Orphanides (2004) for the Burns/Miller, Volcker (and the first part of) Greenspan periods.[8] This data includes, to my knowledge, the best existing proxies for the perceptions policymakers held about the outlook for inflation and the output gap when making policy decisions. Estimates of the linear policy reaction functions for each Fed chair with these data are summarized in Table 2. They parallel those presented in Table 1 of Orphanides (2004) for the case of a one period forecast horizon for inflation. But rather than splitting the sample in the second quarter of 1979 as he does, I split it into subperiods by Fed chairs. Since the real-time data is only available from 1966:1 to 1995:4, Greenspan's term is not fully covered and Martin's period is excluded. The Taylor rule for Volcker's period is estimated twice. Once with and once without the first 3 years of his tenure when the Fed was targeting a nominal stock rather than the FFR (Volcker L and Volcker S in Table 2, respectively).

[8] Nonlinear reaction function are not shown since the nonlinear least squares (NLLS) used to pinpoint the parameters of the nonlinear version did not yield sufficiently tight estimates.

Figures 2 (a)–(c) show counterfactual dynamic simulations structured as those in Figures 1 (a)–(c) for the paths of the FFR. As before there are two panels in each figure. The first panel shows the counterfactual path for either Volcker or Greenspan along with the path implied by The Burns/Miller reaction function. The second panel shows the difference between the paths of Volcker's or Greenspan counterfactuals and that of Burns/Miller.

A quick look at the figures confirms that the two main messages of the previous subsection are robust to the use of real time rather than retrospective data. Even with real-time misperceptions, if policy in the 1970s had been conducted in Volcker's style, it would have been tighter than the one implied by Burns/Miller policy rule. And if policy had been conducted in the style followed by Greenspan during his first 8 years as chair, it would have been uniformly looser than the one implied by the Burns/Miller rule. Although this does not rehabilitate the actual policy process during the 1970s, the comparison with Greenspan provides a somewhat less sanguine perspective on the policy errors of the 1970s.

INFLATIONARY EXPECTATIONS AND THE GREAT INFLATION

Led by its New Keynesian reincarnation, the current theory of monetary policy assigns a central role to inflationary expectations in the propagation of inflation. Although policymakers in the 1970s were not blind to shifting inflationary expectations, some of their policy errors might have been due to insufficient attention to the effects of policy on these expectations. Only after the inflationary experience of the 1970s did policymakers realize the prime role of expectations in the transmission and perpetuation of the inflationary process.[9] In addition, to the extent that they underestimated future inflation, policymakers might have been led to believe that they were setting higher real rates than what turned out to be the case with the benefits of hindsight.

This section takes a look at those issues by using inflation forecasts from the Fed's GB to proxy for real-time inflationary perceptions of policymakers and data on survey expectations from the SPF and the LS to proxy for the public's expectations.[10] The first part of this section utilizes the Fed's GB inflation forecasts to evaluate the difference between the real rates that policymakers thought they were setting and the actually realized real rates.

[9] Thus, in a testimony to a Congressional committee Volcker states; 'Anticipations of higher prices themselves help speed the inflationary process … ' (Volcker 1980, pp. 2–3). This view is currently firmly enshrined in all modern macroeconomic models.

[10] The GB forecasts have been used in Orphanides (2004) and the SPF and the LS are maintained by the Philadelphia Fed.

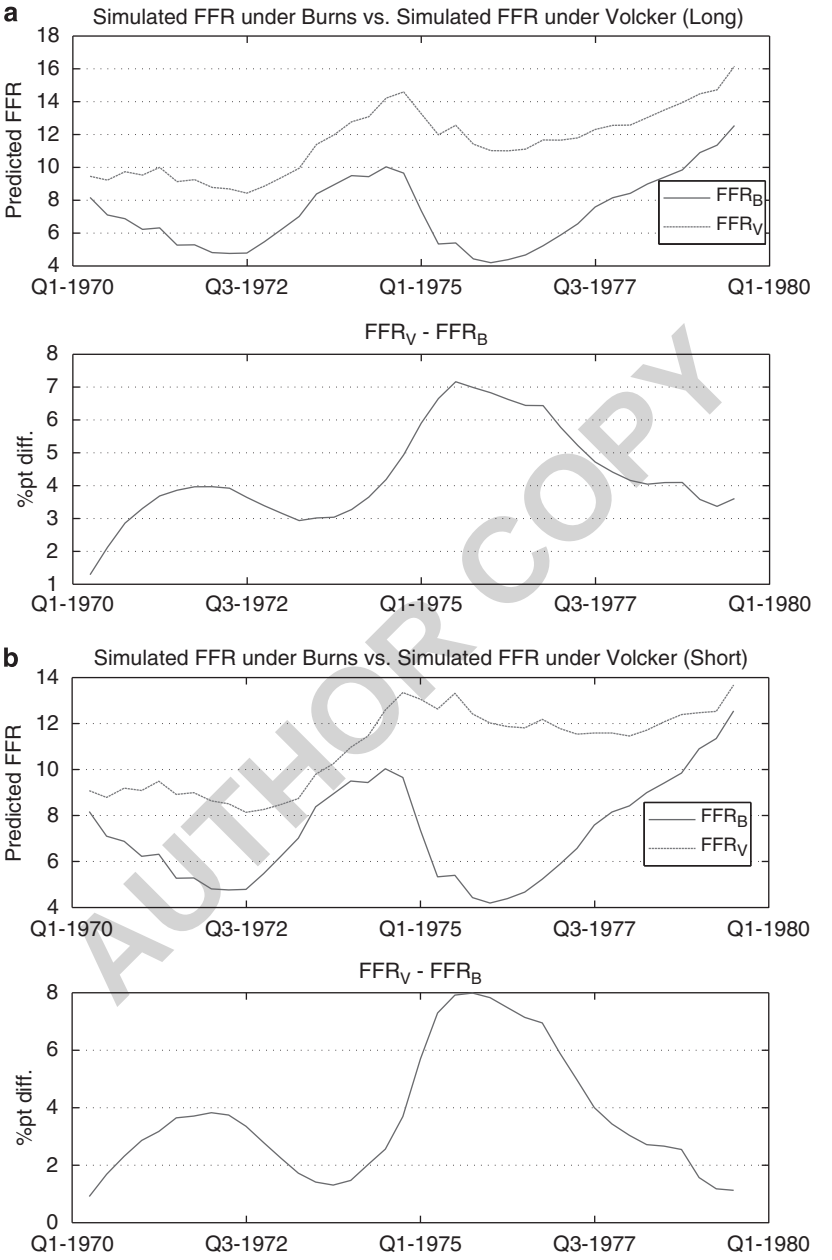

Figure 2: Counterfactual federal funds rates based on real-time data estimates. (a) Counterfactual based on linear Taylor rule estimated with real time data – Volcker (long); (b) Counterfactual based on linear Taylor rule estimated with real time data – Volcker (short); (c) Counterfactual based on linear Taylor rule estimated with real-time data – Greenspan.

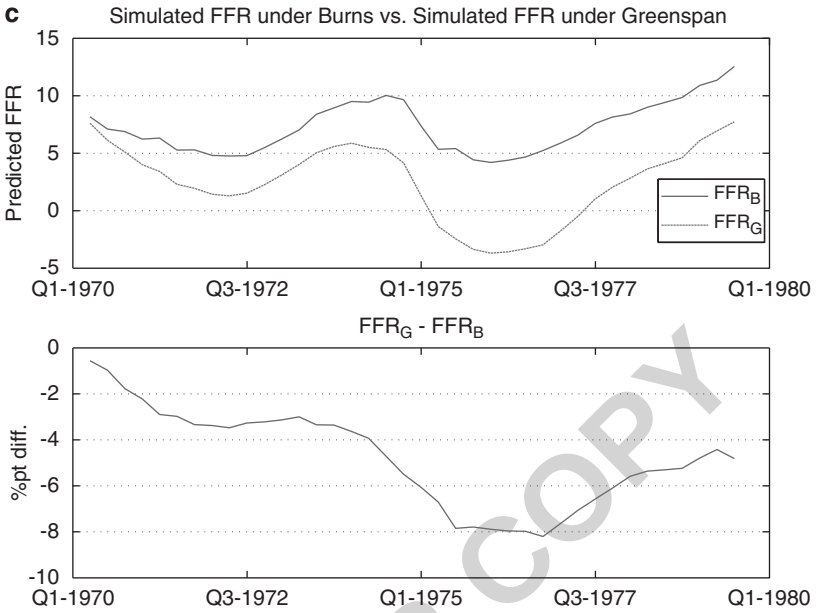

Figure 2: *Continued*.

The second part examines the behavior of unexpected inflation under Burns/ Miller, Volcker and the first part of Greenspan's periods and discusses its relation to previous inflationary experiences.

The impact of inflation uncertainty on the difference between *ex ante* and *ex post* indicators of real policy rates

An important cost of inflation is related to the rise in inflation uncertainty associated with a rise in inflation. Within the private sector, this uncertainty leads to arbitrary redistributions of wealth and to deviations between actual and desirable production. It also injects uncertainty into monetary policy choices. Since monetary policy affects the economy through real rates, policymakers must evaluate the real impact of their *nominal* rate decisions *ex ante* before they know the realization of inflation. This subsection examines how often the FOMC in the 1970s was led to believe *ex ante* that its policy actions led to *real* interest rates that were biased upward in comparison to what these rates turned out to be with the benefit of hindsight. To the extent that, during the 1970s, upward errors in evaluation of real rates were more frequent than errors in the opposite direction part of the inflationary bulge of the time may be traced to overestimation of these real rates. In order

to examine whether the magnitude and the direction of the bias change during and after the stabilization of inflation the figures in this subsection cover the entire period between 1967 and 1995.

Two proxies for *ex ante* real rates as perceived by the FOMC in real time are used. The first is the effective FFR (F_t) minus the 1-year ahead forecast of GNP inflation from the GB in quarter t ($\pi^{GB}_{t,t+1}$).[11] The second is the 1-year treasury bill rate (T_t) minus the 1-year ahead forecast of GNP inflation from the GB in quarter t ($\pi^{GB}_{t,t+4}$). The data for F_t,$\pi^{GB}_{t,t+1}$,$\pi^{GB}_{t,t+4}$ is taken from the data set underlying Orphanides (2004) and data for T_t is from the Federal Reserve Bank of St Louis data set. For future reference it is convenient to define

$$\begin{aligned} F^r_t &\equiv F_t - \pi^{GB}_{t,t+1} \\ T^r_t &\equiv T_t - \pi^{GB}_{t,t+4} \end{aligned} \tag{2}$$

Here F^r_t and T^r_t are proxies for the *ex ante* real content of the FFR and the *ex ante* real 1-year treasury bill rate as perceived by the GB forecasters given the information available to them in quarter t. Let

$$\begin{aligned} F^{ra}_t &\equiv F_t - \pi_{t,t+1} \\ T^{ra}_t &\equiv T_t - \pi_{t,t+4} \end{aligned} \tag{3}$$

be the *ex post* realizations of F^r_t and of T^r_t Here $\pi_{t,t+j}$ denotes actual inflation measured by the rate of change in the GNP implicit price deflator between quarter t and quarter $t+1$. The difference $F^{ra}_t - F^r_t$ is a proxy for the extent to which GB forecasts of the real content of the FFR exceeded its realized value. Similarly, $T^r_t - T^{ra}_t$ is a measure of the extent to which GB forecasts of 1-year treasury bill rates exceeded the actually realized value of those rates. Figures 3 (a)–(b) show the paths of those two differences between 1967 and 1995.

Figure 3 (a) suggests that policymakers' perceptions of the real-time tightness of monetary policy over the upcoming quarter were generally biased upward. During most of the period under consideration, the bias was bounded from above by half a percent tending towards this bound from below in the early 1970s. This bound was exceeded twice during the period. Once after the first oil shock, when the bias rose to 1% and during the

[11] The headline implicit deflator during the 1970s was based on GNP rather than on GDP measures of aggregate productive activity.

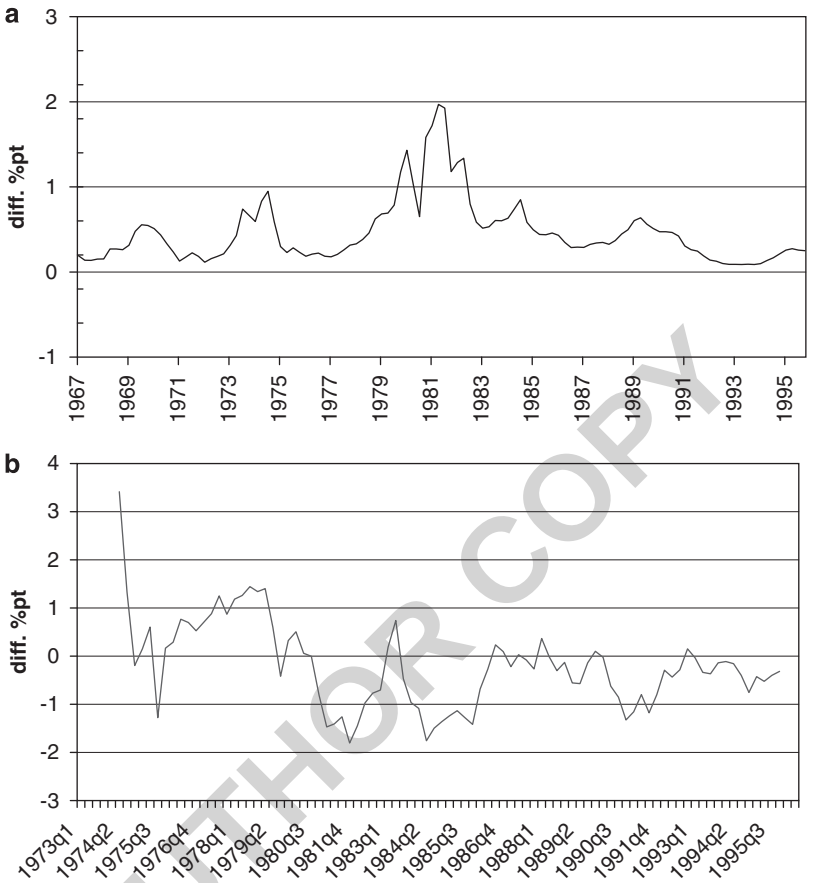

Figure 3: Differences between *ex ante* and *ex post* real interest rates. (a) Difference between the *ex ante* and *ex post* real contents of the federal funds rate, %; (b) Difference between *ex ante* and *ex post* real 1-year treasury bill rates, %.

early phase of Volcker's disinflation when it climbed to an all time maximum of 2%.

It is widely believed that the impact of monetary policy on the real economy is transmitted mainly through the effects it has on longer-term rates.[12] Figure 3 (b) examines whether similar differences arise between *ex ante* and *ex post* real 1-year treasury rates. Over the entire period between

[12] For the 1-year treasury bill rate this belief is backed by the finding that the correlation between F_t and T_t over the sample period is 0.967. The corresponding correlation between the *ex post* real counterparts of F_t and of T_t is 0.925.

1973 and 1995, Figure 3 (b) suggests that over and under predictions of tightness balance each other out rather well. Interestingly, the distribution of over and under predictions is strongly serially correlated. In particular, most of the 1970s are characterized by over predictions of the real treasury rate, while the first 3 years of Volcker's tenure are characterized by under predictions. Another striking feature is that the standard deviation of the forecast error of $T_t^r - T_t^{ra}$ is substantially lower under Greenspan's tenure than before. It is 1.062 before 87:3 and only 0.392 during the first 9 years of Greenspan Chairmanship.[13] As discussed later, this is one of the long-term benefits of Volcker's disinflation. In particular, the nominal stability inherited by Greenspan led policymakers at the Fed to more accurate evaluations of the stance of monetary policy.

A direct look at the behavior of unexpected inflation during the great inflation and its aftermath

This subsection provides evidence on inflation forecast errors during the great inflation and its aftermath. Data on inflationary expectations or forecasts are obtained from three different sources: the SPF, the LS and the Fed's GB forecasts. The first two surveys are currently maintained by the Federal Reserve Bank of Philadelphia and are aimed at capturing the expectations of individuals in the financial and business community. The GB forecasts come from the data set underlying Orphanides (2004) and reflect the real-time forecasts of the staff of the Federal Reserve. The time periods covered differ across surveys. All three sources provide forecasts for a 1-year ahead forecast horizon, as well as for other horizons. The SPF and GB series provide forecasts for the GDP (or prior to the early 1990s) GNP deflator and the LS provides forecasts of CPI inflation.

Figures 4 (a)–(c) show the paths of the 1-year ahead inflation forecast errors implied by data from the SPF, the LS and the GB, respectively. The main conclusions from the figures are: First, except for a relatively short-time interval during the mid-1970s, the magnitude of inflation was systematically underestimated by both policymakers and the public. Second, during Volcker's disinflation forecast errors tend to be negative. This is particularly in evidence for private forecasts and to a lesser extent for the GB forecasts. Third, inflation uncertainty as characterized by the standard deviation of forecast errors is substantially lower since the start of Greenspan chairmanship than during the great inflation and its stabilization. For example, the standard deviation of the 1-year ahead forecast error of GB forecasts goes

[13] Greenspan's period is cut in the middle since the data on the 1-year ahead GB inflation forecasts ends in 95:4.

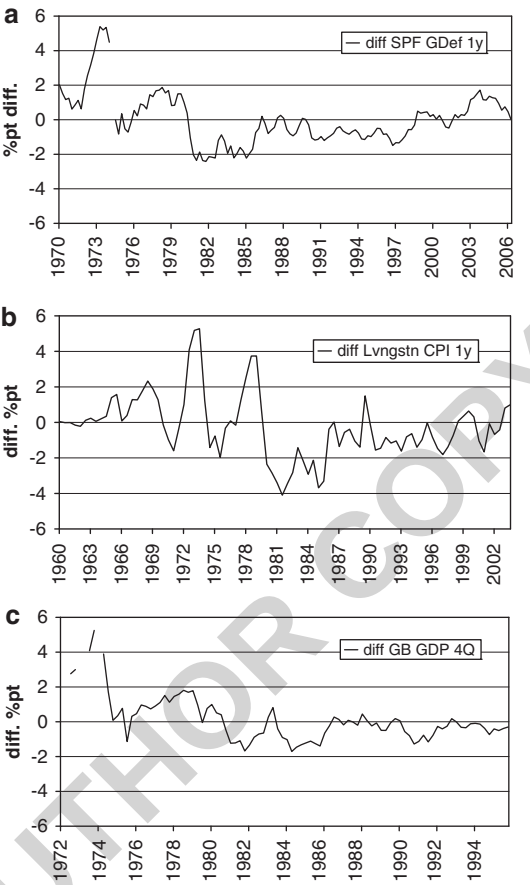

Figure 4: Actual minus forecasted inflation.

down from 1.371 prior to 1987:4 to 0.575 thereafter. Those findings are robust across different forecast sources, as well as across forecast horizons.

CONCLUDING REFLECTIONS

Two main findings of the paper are:

1. if monetary policy during the 1970s had been conducted in Volcker's style, it would have been more restrictive than under Burns/Miller;
2. if monetary policy during this period had been conducted in Greenspan's style, it would have been less restrictive than under Burns/Miller.

Should we conclude from these findings that if either Paul Volcker or Alan Greenspan had been appointed as chairs of the Fed at the beginning of the 1970s and had faced the same external circumstances as Burns did, they would necessarily stick to their respective policy rules? I believe not. A more plausible hypothesis is that the policy rules of both Volcker and Greenspan arose as endogenous reactions to the main problem monetary policy had to tackle when they were appointed. Volcker was appointed when inflation came to be considered the number one economic problem of the day. So he developed a rather conservative rule of conduct. Greenspan, on the other hand, came into office after inflation had been largely stabilized under Volcker. He could therefore deploy more policy effort to the employment objective in the Fed's dual policy mandate.

The broader conjecture is that policy rules, and possibly also the type of individual appointed to chair the Federal Reserve, adapt so as to respond to the main economic problem of the day. Clearly, the counterfactual experiments in the paper are not designed to provide *direct* evidence for or against this hypothesis. However, by showing that Greenspan's rule (which evolved after price stability was reestablished) was more expansionary than that of Burns and that Volcker's rule (which was designed in the midst of high inflation) was more restrictive than that of Burns, the experiments discussed here are consistent with the view that policy rules adapt to deal with the main issue of the day. Direct investigation of this hypothesis is left for future research.

A third finding is that inflation uncertainty was substantially lower under Greenspan than under either Burns/Miller or Volcker. This finding might appear surprising at first blush. However, when one recognizes that the process of rebuilding credibility after high inflation has taken hold is normally clouded with uncertainties, a slow rather than a quick decline in inflation uncertainty is to be expected. For the same reason, the major reduction in inflation uncertainty between Volcker's and Greenspan's terms is largely attributable to the policies deployed under the former. Greenspan's contribution was that he did not spoil the hard earned stability from the Volcker regime and utilized it to devote more of the policy effort to the stabilization of real economic activity without endangering price stability. However, with the benefit of hindsight, it is now apparent (April 2010) that Greenspan's low interest rate policy during the beginning of the twenty-first century contributed to the buildup of the subprime bubble and the ensuing global financial crisis. In conjunction with the expansionary fiscal reaction to the crisis and the associated increase in public debt this may revive inflation in the longer run.

Meltzer (2005) argues that a major reason for the emergence of the great inflation in the early 1970s was Burns' inability to stand up to political pressures. On the other hand Romer and Romer (2004), Sargent (1999) and others argue that the main reason is that, during the 1970s, the Fed believed in faulty models of the economy. My feeling is that there were strong interactions between those two explanations under Burns tenure. In particular, Burns ability to resist political pressures would, most likely, have been much enhanced had there been a consensus about the right model of the economy and the consequent policy recommendations within the economic profession. Unfortunately for him and for his ability to resist political pressures this was not the case. Although a broad consensus emerged later, the decade of the 1970s was characterized by strong policy disagreements between monetarists and Keynesians. Burns alludes to the impact of this controversy in his memoirs by recalling that when monetarists criticized the Fed's policy for not sufficiently deploying policy in one direction while Keynesians assailed him for going too much in that direction, he would safely duck in the middle.

The finding that the Fed's staff underestimated inflation quite often during the 1970s makes it likely that Burn's FOMC did not sufficiently appreciate the importance of inflationary expectations in the propagation of inflation. It is also likely that they were not sufficiently aware of the fact (observed during other high inflation episodes) that the speed of adjustment of nominal prices and wages goes up when a higher rate of inflation becomes sufficiently persistent. The potential quantitative impact of this factor is investigated in Cukierman (2008).

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