A multinominal logit analysis of the influence of policy variables and board experience on FOMC voting behavior

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Allen, S. D., Bray, J. W., & Seaks, T. G. (1997). A multinomial logit analysis of the influence of policy variables and board experience on FOMC voting behavior. Public Choice, 92, 27–39.

The final publication is available at Springer via http://dx.doi.org/10.1023/A:1017983119951

Abstract:

Previous studies have used probit or logit models to analyze two states of monetary policy (tighter or looser). In this paper we employ multinominal logit to permit Federal Reserve monetary policy to assume one of three alternative states (tighter, looser, or no change) as a function of three independent economic variables (unemployment, real growth, and inflation) and the amount of experience of the Board of Governors. The results indicate that the Federal Reserve reacted differently under Burns, Miller and Volcker and between Volcker's two operating procedures in the formulation of monetary policy.

Keywords: monetary policy | multinominal logit | independent economic variables | Federal Reserve

Article:

1. Introduction

In an analysis of Federal Reserve monetary policy, Friedman (1982, p.103) noted “so far as the Federal Reserve System is concerned, the same inability to learn from experience has prevailed under a succession of personalities. Information about the name of the chairman of the Federal Reserve is of little or no use in describing the behavior of the Fed – though the name of the president apparently is.” What is the influence of the Federal Reserve chair on monetary policy? Is Friedman correct that the president has more influence on the outcome of the Federal Reserve policy than the chair?[1] Or is there evidence of different policy responses by the Federal Reserve to key economic variables under various chairs or within a chair’s tenure?

The president, by nominating members to the Board of Governors, has a direct method of influencing monetary policy that is seldom challenged by the Senate’s review of the nominee.[2] Presidents increasingly have been able to make nominations because board turnover has escalated as the opportunity cost of fulfilling a fourteen year term has risen. Whereas Kennedy and Johnson nominated two and three individuals respectively, Nixon and Ford each nominated five individuals to the board. Republican nominees occupied all seven governor’s positions from February 1976 until Miller’s ascension to the chair in March 1978. Carter nominated six governors who occupied five seats, though Volcker’s nomination and replacement of Miller came under duress.
Reagan nominated eight individuals and had appointed all seven governors by May 1986. Yet, governors nominated by the same party can represent opposing points of view. Bush’s three nominees favored reducing interest rates in June 1992 and lobbied the three Reagan appointees who were reluctant to vote for looser policy.[3]

The increased turnover at the Board of Governors has lowered their cumulative experience of the governors (GEX). Governors served an average of 7.8 years between 1965–1969, but average experience fell to 3.3 years during the critical years of 1979–1982 when major policy changes occurred. Average experience increased to 5.4 years between 1983–1985, but declined to 2.9 years between 1986–1988.[4] The change in operating procedures in 1979 and 1982 and the decade of low inflation has occurred under a less experienced board. One

hypothesis is that more chair (CEX) and governor (GEX) experience would translate into greater independence from presidential preferences, while less experience would increase the President's influence on policy.[5] If more

experience is a proxy for credible anti-inflationary policies, then increased experience by the chair or the group of governors would be positive and significantly related to looser monetary policy. A credible Federal Reserve could afford to loosen policy without signalling renewed inflation. A less experienced Chair or group of Governors would find it necessary to tighten policy to grain credibly as inflation fighters. In addition, it can be hypothesized that a higher turnover rate has changed the institutional structure and enabled the new board members to more easily break with old practices and follow their own course of action. Thus, less experience would be associated with tighter monetary policy. It is an empirical question as to how the change in the level of board and chair experience influences Fed policy objectives.[6]

The purpose of this paper is to test the impact of three economic policy objectives (the growth rate, the inflation rate and the unemployment rate) and the level of experience by the chair and the other governors on the probability of the FOMC voting to tighten, loosen or maintain the current monetary policy. Since the FOMC has three policy options, a multinominal logit model is employed to determine the effect of the three policy objectives on the probability that the FOMC votes for a specific policy. A model is estimated for the 1970–1985 period, for the individual Burns, Miller and Volcker periods, and for Volcker's two different operating procedures to assess any difference in responses to the Fed's objectives and any influence from the level of experience of the chair and the board. One advantage of the multinominal logit model is that the Miller period can be estimated separately because the Miller Fed did elect no change and tighter policy, but never elected to loosen policy. Section 2 introduces the multinominal logit model. The results are presented in Section 3. The empirical evidence indicates that there are significant differences among the FOMC votes under Burns, Miller and Volcker and under Volcker's two operating procedures.

2. The model

A multinominal logit model is employed in order to relate the intentions of the Federal Reserve (as measured by one of three policy choices made by the FOMC) to economic policy objectives. There are several benefits to such an approach. First, by analyzing the policy intentions of the Fed as recorded by the FOMC, the problem of analyzing Fed behavior in relationship to an intermediate target is eliminated.[7] Second, many previous studies [e.g. Hakes (1988a,b, 1990), Havrilesky and Gildea (1991a,b), and Gildea (1992)] have modeled the policy intention of the Fed by a probit model which allows only two policy choices to be analyzed: tighter or looser policy. A multinominal logit model of Federal Reserve behavior is employed because the Fed chooses among three policies based on the FOMC directives that specify either tighter policy, looser policy or no change in policy.[8]

Let the variable Z_t be a random variable indicating the policy intention, the choice made by the FOMC. Let $Z_t = 0$ denote no change, $Z_t = 1$ indicate tighter policy, and $Z_t = 2$ represent looser monetary policy.9 Then a multinominal logit model for $P(Z_t = j)$, $j = 0, 1, 2$ can be formulated as:

$$P(Z_t = j) = exp(\beta_j' x_t)/(exp(\beta_0' x_t) + exp(\beta_1' x_t) + exp(\beta_2' x_t)).$$

The usual normalization $\beta_o = 0$ permits us to calculate the probability of no change, tighter, and looser policy as:

$$\begin{aligned} P(Z_t = 0) &= 1/(1 + exp(\beta_1' x_t) + exp(\beta_2' x_t)) \\ P(Z_t = 1) &= exp(\beta_1' x_t)/(1 + exp(\beta_1' x_t) + exp(\beta_2' x_t)) \\ P(Z_t = 2) &= exp(\beta_2' x_t)/(1 + exp(\beta_1' x_t) + exp(\beta_2' x_t)) \end{aligned} \qquad (1)$$

To complete the model, we define the elements of the vector x_t by $x_t = (1, Y_t, P_t, U_t, CEX_t, GEX_t)$ where: Y_t = Greenbook estimate of real GNP growth rate
P_t = Greenbook estimate of the implicit price deflator growth rate Ut = forecast of the unemployment rate

CEX_t = experience of the chairman, and

GEX_t = the cumulative experience of the Board of Governors.

Monthly data is used to estimate the model from February 1970 to December 1985.[10] Three forecasted macroeconomic variables are tested as objectives of Fed policy. The growth and inflation objectives are the Greenbook estimates of real GNP growth and the implicit price deflator growth rate. The Greenbook estimates are three month ahead forecasts. Because no Greenbook estimate was available, the unemployment forecasts were based on a rolling ARMA(1,1) model where the previous 48 months were employed to obtain a one quarter ahead forecasted series for the unemployment rate from February 1970 to December 1985.[11] Rather than use the unemployment rate, the difference between the natural rate of unemployment and the forecasted rate was employed as the policy objective.[12]

In order to examine the effect of cumulative experience of the board members on the setting of monetary policy, two experience measures were created. The variable CEX reflects the number of months the presiding Fed chairman was in office. Thus, CEX = 1 for February 1970, Burns' first month in office and CEX equals 96 for January 1978, Burns' last month in office. CEX is equal to zero for February 1878 the period after Burns left office but before Miller took office. CEX is equal to one in March 1978 and to seventeen for Miller's last full month in office, July, 1979. The variable GEX is similarly defined as the sum of the months in office of the other six governors.

3. The results

Maximum likelihood estimates of the model are computed using LIMDEP 6.0. Parameter estimates of the multinominal logit model are presented in Table 1 for the three policy variables and for the three policy and two experience variables. Estimates for only two policy choices, tighter policy or looser policy, are provided because the normalization $\beta_0 = 0$ means that the coefficients for the choice of no change are all zero. The results indicate that the model is highly significant for testing the null hypothesis that all slope coefficients are zero. The χ^2_6 equals 45.41 for the three policy variables and equals 53.35 for the three policy and two experience variables.[13]

Table 1. Parameter estimates: Policy objectives (1970:2 to 1985:12)

	Policy variables		Policy and experience variables	
Variable	Tighter policy	Looser policy	Tighter policy	Looser policy
Intercept	–1.81	1.36	–0.49	–2.97
	(–2.43)*	(1.82)	(–0.32)	(–1.50)
Growth	0.10	–0.25	0.09	–0.22
	(1.48)	(–3.91)**	(1.39)	(–3.40)**
Inflation	0.14	–0.30	0.05	0.05
	(1.55)	(–2.75)**	(0.37)	(0.35)
Unemployment	–0.68	–0.45	–0.76	–0.22
	(–3.67)**	(–2.62)**	(–3.48)**	(–1.12)
Chair experience			–0.003	0.102
			(0.36)	(0.95)
Chair experience			–0.002	0.006
			(0.97)	(2.30)*
	logL = –152.20 n = 191		logL = –148.23 n = 191	
	$\chi^2(6) = 45.506$**		$\chi^2(10) = 53.35$**	

* Significant at .05 level
** Significant at .01
Asymptotic t ratio in parentheses

For the model that tests only the three policy variables, the individual t- ratios indicate all three objectives are significant in relation to looser policy. Increases in economic growth and the inflation rate reduces the probability of the Federal Reserve loosening monetary policy. However, the unemployment rate has the incorrect sign because a higher unemployment rate should increase the probability that the Fed would loosen policy. The unemployment objective is significant and of the correct sign in relation to tighter policy.

For the model that tests the policy and the experience variables, the growth objective is negative and significant for looser policy and the unemployment objective is negative and significant for tighter policy. These results indicate a defensive posture for the Fed. A higher rate of growth makes the Fed less willing to loosen policy and a higher rate of unemployment makes the Fed less willing to tighten policy. The governor experience coefficient is positive and significant for looser policy indicating that the greater the experience of the governors, not including the chair, the greater the likelihood that the board would vote to loosen policy. This finding is consistent with Belden (1989) and Havrilesky and Gildea who find that governors are more likely to vote for easier monetary policy than the bank presidents.

Conclusions, however, are difficult to draw from the estimated β vector, and it is more useful to examine the partial effects that show the change in the probability of occurrence with respect to a change in an exogenous variable. Green (1993, p. 666) derives the partial effects for our multinominal logit model. Denoting Prob(Z_t j) by P_j, we have:

Table 2. Partial effects: Policy objectives (1970:2 to 1985:12)

Variable	No change	Tighter policy	Looser policy
Growth	0.01	–0.02	–0.03
	(0.85)	(1.57)	(2.19)*
Inflation	–0.001	0.01	–0.01
	(0.06)	(0.43)	(0.42)
Unemployment	0.11	–0.10	–0.01
	(3.19)*	(2.15)*	(0.41)
Chair experience	–0.0005	–0.0006	0.0012
	(0.38)	(0.55)	(0.93)
Governor experience	–0.0003	0.0004	0.0007
	(0.95)	(1.32)	(1.75)*

* Significant at .05 level for a one-tailed test

$$\begin{aligned} \partial P_0/\partial x_t &= P_0(\beta_0 - P_1\beta_1 - P_2\beta_2) \\ \partial P_1/\partial x_t &= P_1(\beta_1 - P_1\beta_1 - P_2\beta_2) \\ \partial P_2/\partial x_t &= P_2(\beta_2 - P_1\beta_1 - P_2\beta_2). \end{aligned} \quad (2)$$

[14]

The partial effects, computed by LIMDEP, are shown in Table 2. An examination of these partial effects indicates the direction of the influence of the objectives on policy as well as their level of significance.[15] The results for looser policy show the Fed reacts to a one point rise in the growth rate of real GNP by decreasing the probability of looser policy by .03. The results for tighter policy show that an increase in unemployment decreases the probability of tighter policy by .10. This evidence suggests that the Fed reacts more defensively than offensively: rising unemployment reduces the probability of tightening, while stronger growth lessens the probability of loosening.[16]

Previous work by Hakes (1990) has argued that the Burns period is significantly different from the Volcker period. In order to test this hypothesis, our sample is divided into periods for each of the three Fed chairs and the model is tested for coefficient stability. Given Miller's short tenure, most studies combine Miller with Burns or eliminate the Miller period entirely. In previous studies when the policy indicator was either to loosen or tighten policy, the Miller period could not be investigated because the Miller Fed never loosened policy because policy was already as loose as it could be. An advantage of our multinominal logit approach is that we can examine Miller's tenure directly because the Fed can choose either to tighten or to maintain the same policy.

Table 3. Test for stability: Three policy objectives

Chair	Subperiod	n	df	χ^2	p-value
Burns	70.02 to 78.02	97			
Miller	78.03 to 79.07	17	12	18.33	0.106
Volcker	79.08 to 85.12	77			
Burns-Miller	70.02 to 79.07	114	8	6.69	0.570
Volcker	79.08 to 85.12	77			
Three policy objectives plus chair and board experience					
Burns	70.02 to 78.02	97	18	30.74	0.031
Miller	78.03 to 79.07	17			
Volcker	79.08 to 85.12	77			
Burns-Miller	70.02 to 79.07	114	12	16.45	0.172
Volcker	79.08 to 85.12	77			

Because of our reliance on ML estimation the estimated coefficients based on a sample of only 17 observations for Miller's tenure must be regarded as exploratory in spirit.[17]

Stability test results based on likelihood ratio testing are reported in Table 3. The null hypothesis of stable coefficient estimates for the model including the three policy objectives is not rejected (p-value = 0.106) when the Burns, Miller and Volcker terms are testing separately. This is also true when Miller and Burns are combined and compared to Volcker. When the experience of the board and the chair is included with the three policy objectives, the null hypothesis of stable coefficient estimates across the three chairs is rejected (p-value = .031). This rejection of stable coefficients between the regimes of the three chairs is based on only seventeen months of data for the Miller tenure.

The parameter estimates for the three chairs are provided in Table 4. The model is highly significant (p-value =.0003) for the Burns period. The results show that a higher unemployment rate under Burns significantly decreased the probability that the Burns' Fed would tighten policy. These results are consistent with other studies that show that the Fed practiced easy monetary policy under Burns.

The model is not significant under Miller, but is significant (p-value = .014) for the Volcker term through December 1985. The results show that a higher rate of growth under Volcker decreased the likelihood that the Fed would loosen policy and that increased experience by the chair increased the probability that the Fed would loosen monetary policy. These results are consistent with the view that the objective of the Volcker Fed was to fight inflation; lean against the wind with regard to economic growth prior to any increase in inflationary pressure. The evidence also is consistent with the fact that increased experience, a proxy for credibility, increased the probability that the Volcker Fed could loosen policy.[18]

A comparison of the coefficient estimates and level of significance between the Burns and Volcker periods reveals that the Fed reacted differently under the Burns and the Volcker periods. Significance levels are for one- tailed tests reported in parentheses. The Burns Fed decreased the probability of tightening policy (1% level) when unemployment increased relative to the response of the Volcker Fed. The Volcker Fed decreased the

probability of loosening policy (5% level) in response to higher rates of real GNP growth relative to the Burns Fed (1% level).

Table 4. Parameter estimates: Burns, Miller and Volcker

	Burns 70:2–78:2		Miller 78:3–79:7	Volcker 79:8–85:12	
Variable	Tighter	Looser	Tighter	Tighter	Looser
Intercept	–3.51	0.94	7.77	3.71	–9.95
	(1.07)	(0.40)	(0.78)	(0.78)	(1.44)
Growth	0.05	–0.13	0.06	0.21	–0.35
	(0.41)	(1.63)	(0.22)	(1.49)	(1.78)
Inflation	0.08	–0.07	–1.03	–0.31	–0.66
	(0.32)	(0.40)	(1.12)	(1.08)	(1.50)
Unemployment	–1.07	0.22	3.42	–0.65	–0.24
	(2.71)**	(0.63)	(0.56)	(1.54)	(0.47)
Chair	–0.03	–0.03	–0.18	–0.06	0.20
experience	(1.01)	(1.33)	(0.88)	(0.99)	(1.83)
Governor	–0.02	0.00	0.01	–0.00	–0.02
experience	(0.39)	(0.10)	(0.22)	(0.10)	(0.73)
	$\chi^2(10) = 32.63$		$\chi^2(5) = 7.83$	$\chi^2(10) = 22.29$	
	[0.0003]		[0.17]	[0.014]	
	logL = –82.50		logL = –7.60	logL = –42.75	
	n = 97		n = 17	n = 77	

** Significant at .01 level
Asymptotic t ratio in parentheses
P-value in brackets

Table 5. Test for stability: The Volcker tenure

Subperiods	n	df	χ^2	p-value
79.08 to 82.06	35	8	21.956	0.005
82.07 to 85.12	42			
79.08 to 82.09	38	8	22.531	0.004
82.10 to 85.12	39			

It is commonly accepted that Volcker changed operating procedures during his tenure. Thus, the stability of the coefficient estimates also can be tested over these two operating procedures. There are two possible dates at which to divide the Volcker period. The first is July 1982 when the federal funds rate began to decline and the second in October 1982 following Volcker's speech early in the month when he acknowledged that the Fed was changing its operating procedure. The Volcker period was divided into subperiods based on both of these dates and the coefficients tested for stability. For either break point, the null hypothesis of stability is rejected at the one percent level based on the x28. When the experience variables were included in the model, the estimation procedure did not converge to a global maximum, so the results are not reported.

The parameter estimates for Volcker's two operating procedures, divided between September and October 1982, are provided in Table 6. The x26 indicates that the model is significant at the one percent level for the first operating procedure. An increase in the unemployment rate decreases the likelihood of tighter policy during the first operating procedure. This evidence shows that the Volcker Fed responded in a statistically significant manner to rising unemployment during the so-called Monetarist experiment from October 1979 to September 1982. The model is not significant at the ten percent level for the second operating procedure for either breaking point. Only one coefficient estimate is significant at the five percent level during the 1982:10-

1985:12 period. A higher rate of real GNP growth decreased the probability of looser policy being implemented by the Fed. The low level of significance of the model and the lack of statistically significance parameter estimates may indicate that the Fed followed a more eclectic monetary policy during the latter period.

4. Summary

The purpose of this paper has been to estimate the influence of three policy objectives and the experience of the chair and the board on the intent of FOMC policy as determined by the three policy choices faced by the Federal Reserve at every FOMC meeting. The Fed votes on one of three possible policy directives: to tighten, loosen, or maintain the same policy. A multinominal logit model is able to handle three policy choices and is estimated for the 1970:2 to 1985:12 period and for separate periods for the Burns, Miller and Volcker tenures as chair. The evidence reveals that the Fed reacted differently to its three policy objectives: growth, inflation and unemployment under each of the three chairs when the three policy variables and two experience variables of the chair and the board are included in the tested model. In addition, the evidence indicates that the Fed reacted differently to the policy variables during the two different operating procedures employed by the Volcker Federal Reserve.

Table 6. Parameter estimates: Volcker's two operating procedures

Variable	1979:08–1982:09		1982:10–1985:12	
	Tighter	Looser	Tighter	Looser
Intercept	1.77	–78.21	–0.64	–0.12
	(0.49)	(0.98)	(0.19)	(0.04)
Growth	0.12	–1.45	0.30	–0.63
	(0.61)	(1.04)	(1.06)	(1.70)
Inflation	–0.07	5.44	–0.97	0.53
	(0.20)	(0.94)	(1.03)	(0.52)
Unemployment	–1.89	7.11	0.38	–1.10
	(2.32)*	(0.97)	(0.71)	(1.08)
	$\chi^2(6) = 21.47^{**}$ [0.002]		$\chi^2(6) = 9.17$ [0.16]	
	logL = –14.835		logL = –22.663	

* Significant at .05 level
** Significant at .01 level
Asymptotic t ratio in parentheses
P-value in brackets

Notes:

1. The effect on monetary policy from signalling by the Administration has been investigated by Havrilesky (e.g. 1988, 1991) in a series of articles.
2. LaWare's nomination by Reagan in 1988 was influenced by the necessity of nominating an individual acceptable to the Democratic-controlled Senate.
3. *The Wall Street Journal*, "Fed officials, meeting next week, are facing policy confrontation", June 28, 1992, p. A1.
4. Average experience is based on the board's composition in the fourth quarter.
5. Havrilesky (1991) suggests that a supply-side coup occurred around 1985 as four supply- side economists, supportive of President Reagan, became governors. The paper does not test for the factors that influence the votes of individual FOMC members. See Tootell (1991a,b), Havrilesky and Gildea (1991a,b), and Chappel, Havrilesky and McGregor (1993) and their references for an introduction to this literature. Rather we are testing whether the cumulative experience of the chair and the other governors has any significant effect on voting by the FOMC.
6. A referee noted that the experience variable could be a proxy variable for the buildup of political pressure from the Administration to the Chair to practice easier monetary policy. Bray (1992) attempted to include both administrative and chair variables. However, the two dummy variables combined to

perfectly predict one of the categories of the dependent variable, and thus the maximum likelihood results did not converge and gave spurious results. See Davidson and MacKinnon (1993, p. 520). Thus, it is not possible to test the Administrative-specific influences in addition to the experience variables. See Havrilesky (1993) and other cited articles by Havrilesky for administration effects on monetary policy.

7. See Tootell (1991b, pp. 4–5) and Luckett and Potts (1978). Any movement in an intermediate target may not indicate a change in Fed policy if an independence shock has caused the Fed to change its intermediate target in an effort to keep monetary policy unchanged. In addition, there has been disagreement as to the correct or optimal intermediate target.
8. Another possible approach is to use an ordered probit model (e.g. Chappell, Havrilesky and McGregor). A difficulty with such an approach is that "no change" cannot always be regarded as intermediate between tighter and looser monetary policy. If no change occurs following a tightening, it will not necessarily mean the same thing as if no change follows a previous loosening. All we can say with any confidence is that the Fed has opted for no change, and thus we think the multinominal approach is correct.
9. The policy indicator series, Zt, reflects the votes of the FOMC as determined from reading the FOMC minutes. The data is courtesy of G.M. Tootell whose data set is based on FOMC meetings, and not monthly observations, so several modifications are necessary. Some months contained more than one observation. Only the observation which constituted a change in policy was used in such cases. If all observations in a month showed no change, then the last observation in that month was used. In no case did policy reverse itself within a month, and in no case were there more than two observations per month. For any month in which there was not an observation, the policy choice was assumed to be for no change, since no change in policy was made.
10. There is a five year delay in the release of the Greenbook data, so the data set ends in December 1985. For any month which contained two observations, the Greenbook observation was used which corresponded to the value of the policy indicator used. To adjust for months in which no Greenbook observation was available, exponentially smoothed values were used. The series was smoothed after deletion of multiple observations, and all values up to the missing values were used in the smoothing process, including any smoothed values already substituted. Tootell's data prior to 1966 indicated only tighter or looser policy by the Federal Reserve.
11. Two other forecasts were estimated. See Bray (1992). Fitted values from a sixth order VAR (for the entire sample period) on the growth rate of the industrial production index, the growth rate of the wholesale price index, and the unemployment rate were employed. Hakes (1988) employed a similar method. The VAR model had extremely low adjusted R2 and F values and provided poorer results compared with the basic Greenbook forecasts model. Lagged values for the three policy objectives produced chi-square statistics similar to those obtained for the Greenbook forecasts model. Future research could employ this fact to investigate a wider timer period.
12. See Gordon (1990, Table A-2) for the natural rate of unemployment series.
13. The results for the three policy variables is only slightly less significant (X^2 than $_6$ = 39.34) if the level rather the difference of the forecasted unemployment rate had been employed.
14. Note that in the case of ordinary logit (Z = 0 or 1), $\partial P_1/\partial x_t = P_1(1-P_1)\beta$ is the familiar result. This is exactly what results from equation (2) if j=1. Observe also in equation (2) that even though the normalization $\beta 0 = 0$ is used, $\partial P_0/\partial x_t$ is not in general zero.
15. Greene (1993) notes that even where the partial effects are reported, it is rare to see standard errors reported for the partials. This should change now that the asymptotic standard errors of the partial effects can be easily computed in LIMDEP 7.0. See Greene (1995) for details. The partial effects shown in Table 2 are similar in sign and in terms of the relative significance to the parameter estimates reported in Table 1.
16. The partial effect of unemployment on the probability of no change is not the expected sign. A one point rise in the unemployment rate increases the probability of "no change" by. 11. We would expect that a higher unemployment rate would have a positive impact on the probability of looser monetary policy, but not that a higher unemployment rate would increase the probability of no change in policy.

17. February 1978, the month between the Burns and Miller tenures, was assigned to Burns.
18. The evidence is consistent with the alternative view that the experience variable is a proxy for cumulative pressure from the administration which caused Volcker to give into political pressure and loosen monetary policy.

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