

EC 831: Empirical Methods in Macroeconomics

Aeimit Lakdawala

Michigan State University

Were There Regime Switches in U.S. Monetary Policy?

Structural Model

$$\begin{aligned}y_t' A_0(s_t) &= x_t' A_+(s_t) + \varepsilon_t' \\p(s_t = i | s_{t-1} = k) &= p_{ik} \\ \varepsilon_t | Y_{t-1} &\sim N(0, I_n)\end{aligned}$$

$$y_t: n \times 1$$

$$x_t: m \times 1$$

$$A_0(s_t): n \times n$$

$$A_+(s_t): m \times n$$

$$y'_t = x'_t B(s_t) + u'_t(s_t)$$

$$u'_t(s_t) = A_0(s_t)^{-1} \varepsilon'_t$$

$$E[u_t(s_t)u_t(s_t)'] = (A_0(s_t)A_0(s_t))^{-1}$$

where $B(s_t) = A_+(s_t)A_0^{-1}(s_t)$

Unrestricted Time Variation

Example: Suppose we have monthly data

- 13 lags
- 6 endogenous variables
- 3 regimes

$\Rightarrow A_+(s_t)$ has 1404 parameters!

Restrictions on time variation

$$A_+(s_t) = D(s_t) + \bar{S}A_0(s_t)$$

where $\bar{S} = \begin{bmatrix} I_n \\ 0_{(m-n) \times n} \end{bmatrix}$

If we put a prior on $D(s_t)$ with mean zero then we have the Minnesota prior!

"This ties our beliefs about lagged effects of structural innovation i on variable j to our beliefs about contemporaneous effects of innovation i on variable j ."

$$\mathbf{a}_{0j}(s_t), d_{ij,\ell}(s_t), c_j(s_t)$$
$$= \begin{cases} \bar{\mathbf{a}}_{0j}, \bar{d}_{ij,\ell}, \bar{c}_j & \text{Case I} \\ \bar{\mathbf{a}}_{0j}\xi_j(s_t), \bar{d}_{ij,\ell}\xi_j(s_t), \bar{c}_j\xi_j(s_t) & \text{Case II} \\ \mathbf{a}_{0j}(s_t), \bar{d}_{ij,\ell}\lambda_{ij}(s_t), c_j(s_t) & \text{Case III} \end{cases}$$

Case I: Constant coefficients and variances

Case II: Time-varying variances only

Case III: Time-varying coefficients and variances

Monthly U.S. Data from 1959:Q1 to 2003:Q3

- Commodity Price Index (Pcom)
- M2 Divisia (M)
- Federal Funds Rate (R)
- Real GDP (y) (interpolated)
- Core PCE Price Index (P)
- Unemployment Rate (U)

Identifying Restrictions on $A_0(s_t)$

TABLE 1—IDENTIFYING RESTRICTIONS ON $A_0(s_t)$

Variable (below)	Sector (right)	Inf	Fed	MD	Prod	Prod	Prod
Pcom		X					
M		X	X	X			
R		X	X	X			
y		X		X	X	X	X
P		X		X		X	X
U		X					X

Figure: X indicates unrestricted parameter, blank means 0 restriction Inf: Commodity market, MD: Money Demand, Fed: Fed behavior, Prod: Production Sector

Constant: a constant-parameter BVAR (i.e., all equations are Case I);

Variances only: all equations are Case II;

Monetary policy: all equations except the monetary policy rule are Case II, while the policy rule is Case III;

Private sector: equations in the private sector are Case III and monetary policy is Case II;

All change: all equations are Case III.

TABLE 2—COMPREHENSIVE MEASURES OF FIT

Log marginal data densities				
Constant	12,998.20			
	Variances only	Monetary policy	Private sector	All change
2 states	13,345.71	13,383.36	13,280.74	13,308.80
3 states	13,434.25	13,446.13	13,380.77	13,426.78
4 states	13,466.86	13,480.18	*	*
5 states	13,455.26	13,400.10	*	*
6 states	13,510.31	*	*	*
7 states	13,530.71	*	*	*
8 states	13,540.32	*	*	*
9 states	13,544.07	*	*	*
10 states	13,538.03	*	*	*

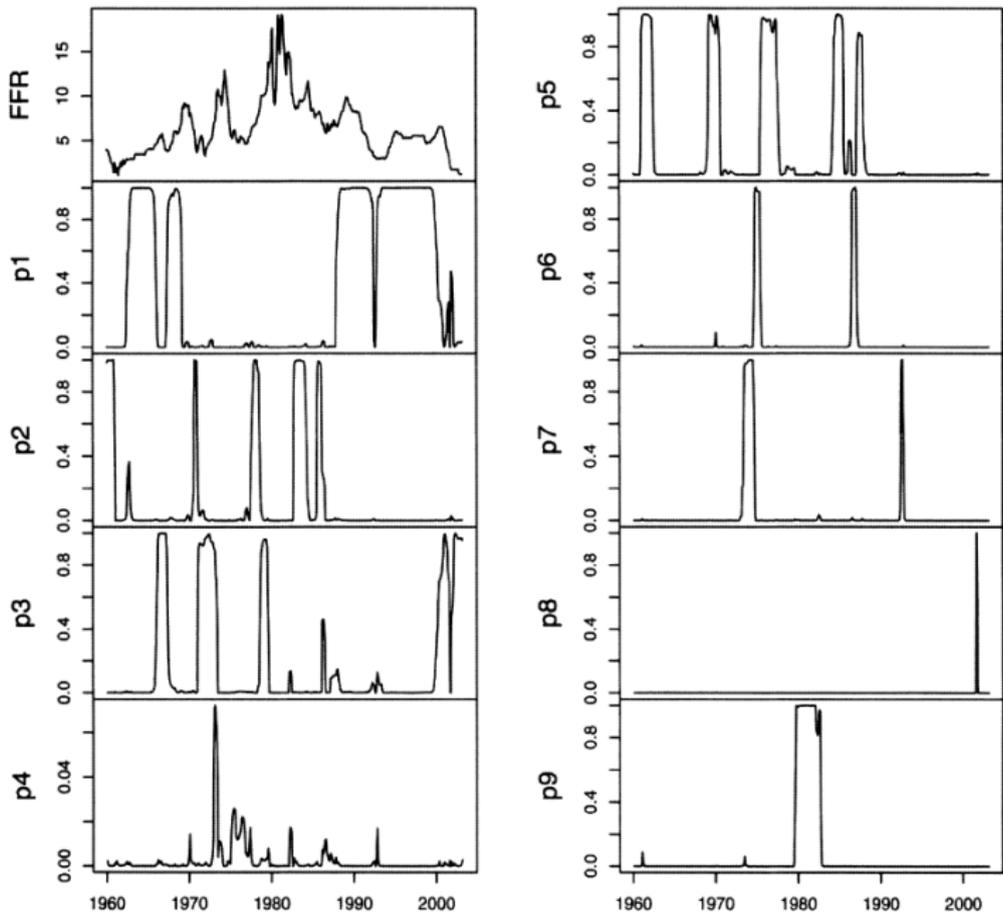
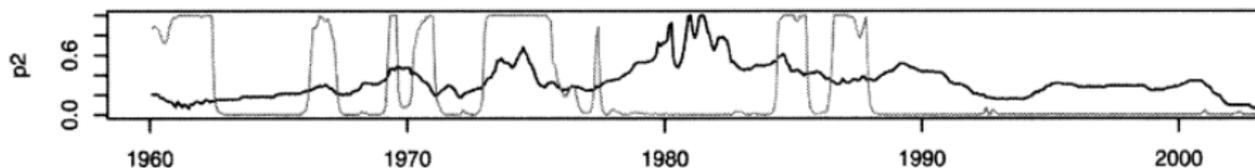
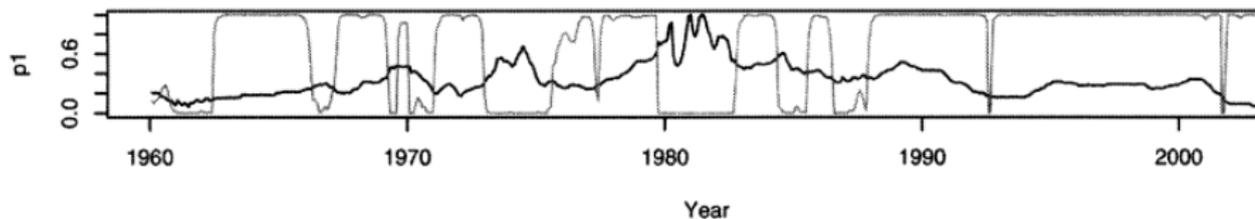


FIGURE 1. NINE-STATE VARIANCES-ONLY PROBABILITIES

TABLE 4—RELATIVE SHOCK STANDARD DEVIATIONS ACROSS STATES FOR NINE-STATE VARIANCES-ONLY MODEL

	Financial	M policy	M demand	Private y	Private P	Private U
First state	1.00	1.00	1.00	1.00	1.00	1.00
Second state	0.95	1.47	1.03	2.07	1.19	1.69
Third state	1.28	1.65	1.84	1.11	1.12	0.91
Fourth state	2.01	2.65	1.93	1.59	1.29	1.37
Fifth state	1.38	2.95	1.24	1.01	0.96	1.17
Sixth state	2.67	2.99	2.32	2.52	0.95	2.13
Seventh state	2.40	4.43	1.21	1.59	2.58	1.05
Eighth state	2.55	4.49	11.44	4.10	10.48	2.67
Ninth state	1.49	12.57	1.53	1.44	1.48	1.44

4 State Monetary Policy Changing



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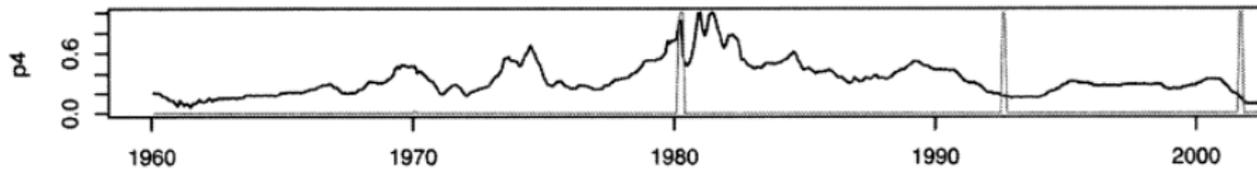
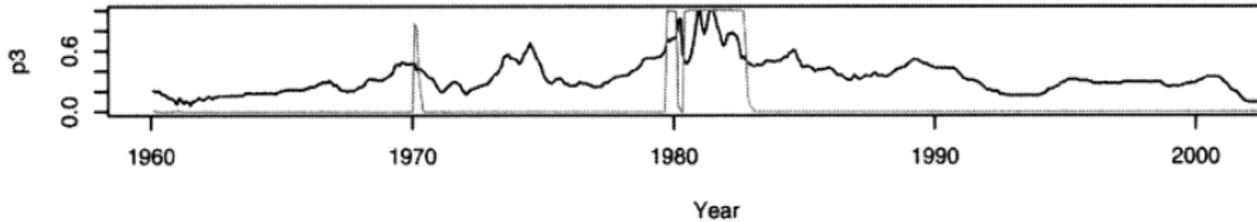


TABLE 8—CONTEMPORANEOUS COEFFICIENT MATRIX FOR FIRST STATE IN FOUR-STATE POLICY-ONLY MODEL

	Financial	M policy	M demand	Private y	Private P	Private U
Pcom	68.03	0.00	0.00	0.00	0.00	0.00
M	34.19	-208.60	-559.30	0.00	0.00	0.00
R	-32.62	559.48	-172.64	0.00	-0.00	0.00
y	-4.49	0.00	11.87	272.37	-17.51	51.94
P	8.65	0.00	-54.58	0.00	-1029.19	25.45
U	84.70	0.00	0.00	0.00	0.00	705.57

TABLE 9—CONTEMPORANEOUS COEFFICIENT MATRIX FOR SECOND STATE IN FOUR-STATE POLICY-ONLY MODEL

	Financial	M policy	M demand	Private y	Private P	Private U
Pcom	38.20	0.00	0.00	0.00	0.00	0.00
M	19.20	-221.50	-401.63	0.00	0.00	0.00
R	-18.32	188.29	-123.97	0.00	-0.00	0.00
y	-2.52	0.00	8.52	206.87	-13.72	42.40
P	4.86	0.00	-39.19	0.00	-806.18	20.77
U	47.56	0.00	0.00	0.00	0.00	576.00

TABLE 10—CONTEMPORANEOUS COEFFICIENT MATRIX FOR THIRD STATE IN FOUR-STATE POLICY-ONLY MODEL

	Financial	M policy	M demand	Private y	Private P	Private U
Pcom	50.43	0.00	0.00	0.00	0.00	0.00
M	25.35	-393.51	-241.46	0.00	0.00	0.00
R	-24.18	136.05	-74.53	0.00	-0.00	0.00
y	-3.33	0.00	5.12	235.35	-12.82	41.12
P	6.41	0.00	-23.56	0.00	-753.62	20.15
U	62.78	0.00	0.00	0.00	0.00	558.70

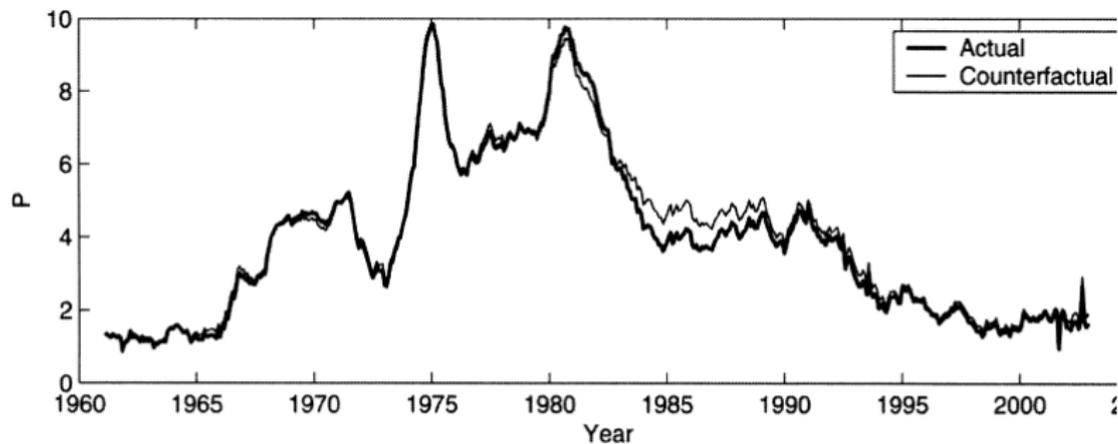
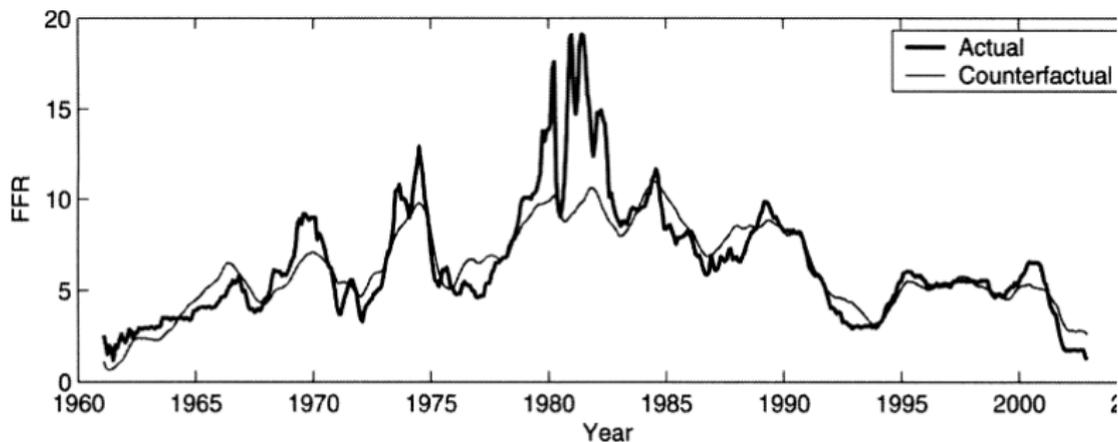


FIGURE 4. COUNTERFACTUAL PATHS WITH NO COEFFICIENT CHANGES AND NO POLICY SHOCKS
(Nine-state, variances-only model)

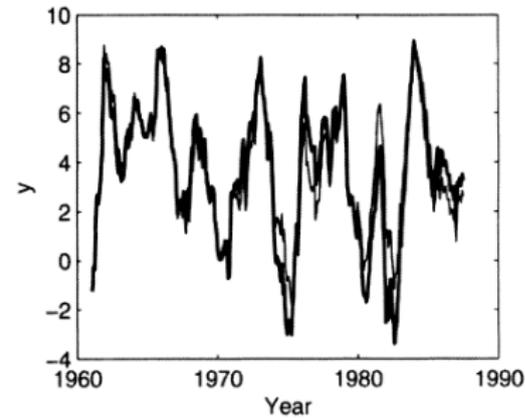
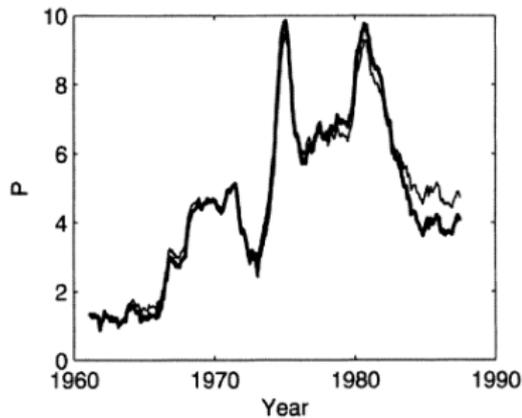
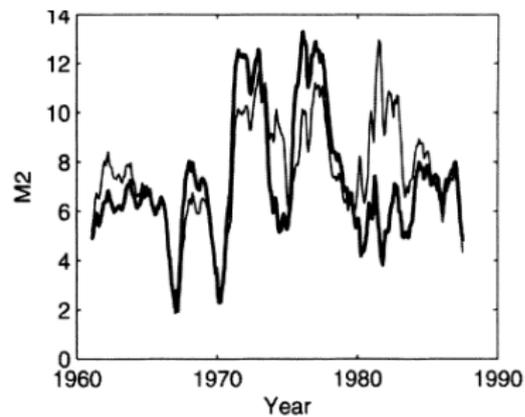
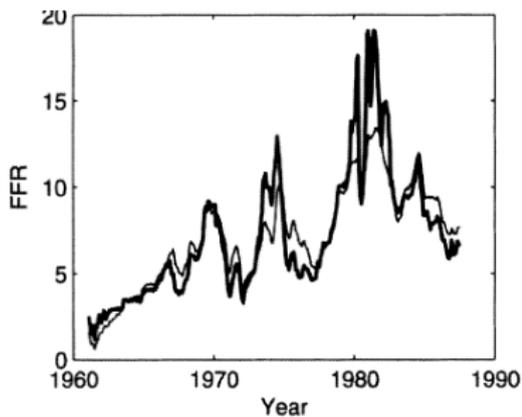


FIGURE 5. FIXED GREENSPAN POLICY THROUGHOUT 1961-1987
(Four-state monetary policy model)

Note: Each graph shows the actual path (thick line) and the counterfactual path (thin line).

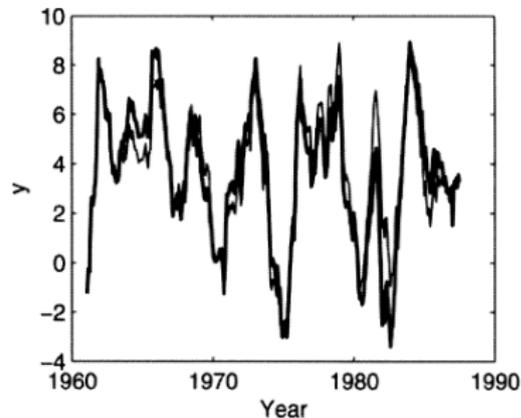
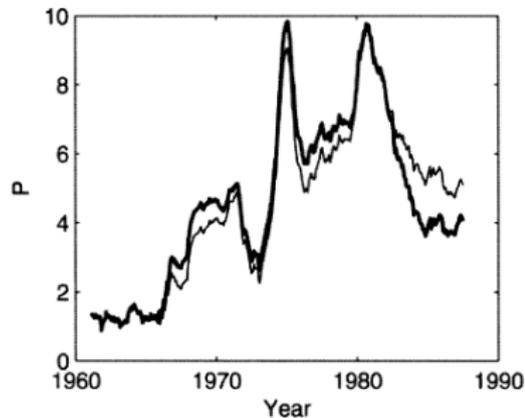
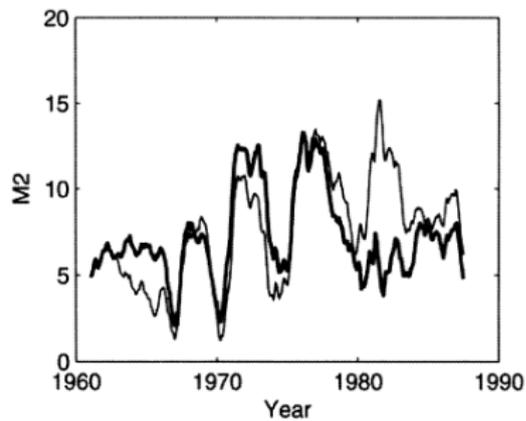
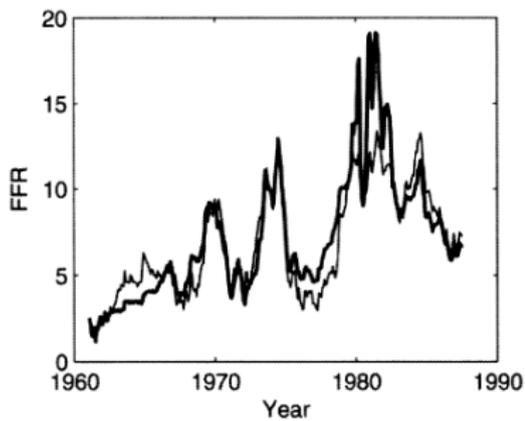


FIGURE 6. FIXED BURNS POLICY THROUGHOUT 1961–1987
(Four-state monetary policy model)

Note: Each graph shows the actual path (thick line) and the counterfactual path (thin line).

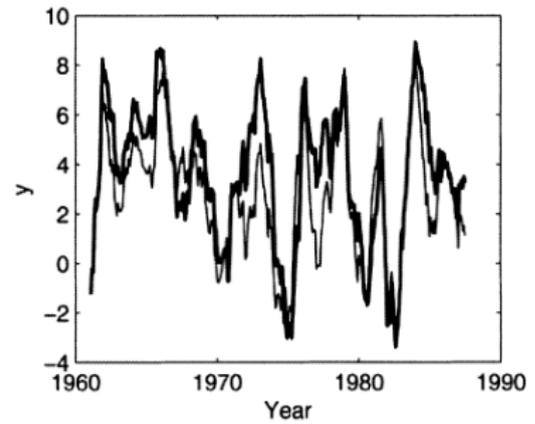
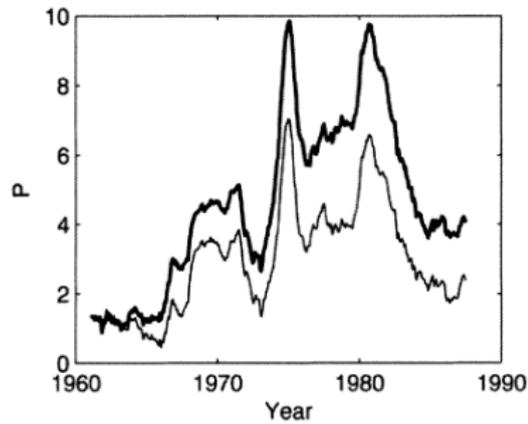
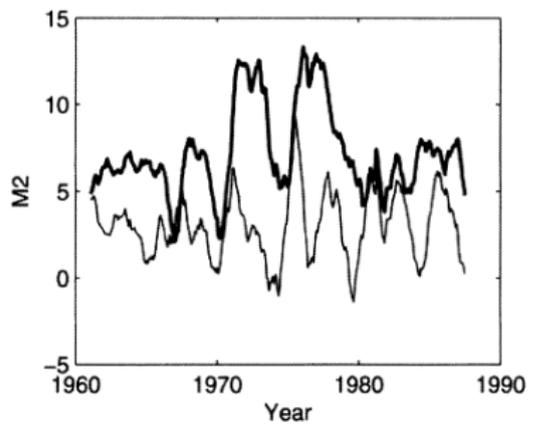
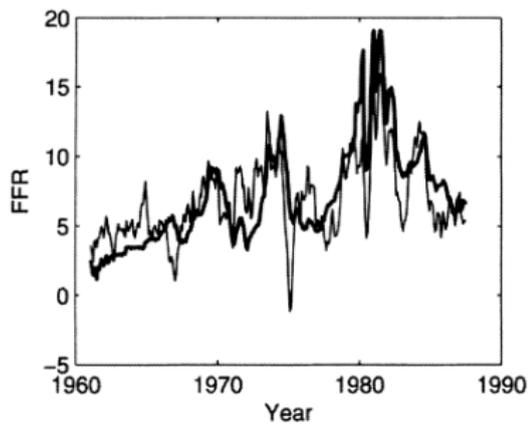


FIGURE 7. FIXED VOLCKER POLICY THROUGHOUT 1961-1987
(Four-state monetary policy model)

Note: Each graph shows the actual path (thick line) and the counterfactual path (thin line).

"Our best-fit model suggests that neither additive disturbances to a linear monetary policy reaction function nor changes in the coefficients of that function have been a primary source of the rise and fall of inflation over our sample period."