# EC 831: Applied Methods in Macroeconomics

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**Changes in Federal Reserve Preferences**

# Motivation

Federal Reserve has a dual mandate

- Full Employment
- Price Stability

Short-run tradeoff between these two objectives

- Relative weight on inflation vs output is a crucial input into monetary policy decisions

# Motivation

- Fed preferences can help us understand the deeper motivations behind monetary policy decisions
- Did preferences play a role in the Great Inflation or the Great Moderation?
- Changes in preferences can provide a new measure of monetary policy shocks
- Theoretical work has shown preferences can have specific effects on interest rates

# Taylor Rules

Taylor type rules are reduced form representations of monetary policy behavior

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Parameters $(B, C)$ are functions of central bank preferences and structural parameters of the economy

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- Cannot identify Fed preferences.

# Modeling Monetary Policy Changes

Considerable interest in changes in monetary policy behavior

Split Sample

- Clarida, Gali & Gertler (2000), Bovin & Giannoni (2006)

Time-varying parameter

- Boivin (2006), Kim and Nelson (2006), Ang et. al (2009), Primiceri (2005), Cogley & Sargent (2005), Fernandez-Villaverde et. al (2010)

Regime-switching

- Sims & Zha (2006), Bianchi (2011), Liu, Waggoner & Zha(2010)

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$\Rightarrow$ **Need an optimizing model of central bank behavior to identify preferences**

# This paper

Using a simple model of optimizing central bank behavior

- Estimate a time varying series of Fed preferences
- Develop a Bayesian Markov Chain Monte Carlo algorithm that uses the Extended Kalman Filter to handle the non-linearities
- Construct a new measure of monetary policy shocks
- Counterfactual analysis involving “Great Inflation” and “Great Moderation”

# Preview of Results

- Gradual variation in the preference parameter
- New measure of monetary policy shocks: Effects on output and prices similar to the VAR literature
- "Volcker-style" preferences would have lowered inflation but not avoided the Great Inflation
- Neither preferences nor size of shocks can completely account for Great Moderation

# Overview

1. Why would preferences change over time?
2. Simple model of central bank behavior
3. Time-varying inflation target?
4. Estimation
5. Results and applications of time-varying preferences

# Why would preferences change over time?

1. Changing composition of Federal Open Market Committee
   - Appointment of new Chairman
   - Voting members change frequently
2. Political pressure on the Fed

# Political pressure on the Fed

**Ehrlichman (1982)**

> *"I know there's the myth of the autonomous Fed... [short laugh] and when you go up for confirmation some Senator may ask you about your friendship with the President."— Richard Nixon to Arthur Burns*

**Arthur Burns (1987)**

> *"... the Federal Reserve was itself caught up in the philosophic and political currents that were transforming American life and culture"*

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**Meltzer (2011)**: Politics and the Fed
**Havrilesky (1995)**: Pressures on American Monetary Policy

# Related Literature on Fed Preferences

**Split Sample Approach**

Ozlale(2003), Favero and Rovelli(2003), Ilbas(2010),Best (2009), Salemi (2006), Dennis(2006),

- Pre and Post Volcker comparisons
- Find that weight on inflation has risen in the post-Volcker sample

**Regime Switching**
Owyang & Ramey (2004)

- Treat central bank preference parameter as two state Markov switching process
- Find multiple switches between hawk and dove regime

# Model

Central Bank chooses the interest rate to minimize a loss function subject to the dynamic constraints of the economy.

Loss Function

- Keep inflation close to target
- Keep output gap close to zero
- Smooth interest rates

Constraints

- IS Curve: Governs behavior of output gap
- Phillips Curve: Governs behavior of inflation

**Weight on inflation relative to output gap allowed to drift over time**

# Model

$$\min_{i_t} L = \tilde{E}_t \sum_{j=0}^{\infty} \beta^j \left[ \alpha_t \left( \pi^a_{t+j} - \pi^* \right)^2 + \tilde{y}^2_{t+j} + \nu (i_{t+j} - i_{t+j-1})^2 \right] s.t.$$

# Model

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$$\tilde{y}_t = a_0 + a_1 \tilde{y}_{t-1} + a_2 \tilde{y}_{t-2} + a_3 \left[ i^a_{t-1} - \pi^a_{t-1} \right] + g_t$$

$$\pi_t = b_0 + b_1 \pi_{t-1} + b_2 \pi_{t-2} + b_3 \pi_{t-3} + (1\text{-}b_1\text{-}b_2\text{-}b_3) \pi_{t-4} + b_4 \tilde{y}_{t-1} + v_t$$

# Optimal Policy Rule

**Assumption**: Central bank treats preference parameter ($\alpha$) as constant.

- Negelect possibility of future update and associated uncertainty.

$\Rightarrow$ Linear quadratic techniques applicable

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Optimal interest rate rule

$$\begin{aligned} i_t &= f_t + F_{1,t}\pi_t + F_{2,t}\pi_{t-1} + F_{3,t}\pi_{t-2} + F_{4,t}\pi_{t-3} + \\ &\quad F_{5,t}\tilde{y}_t + F_{6,t}\tilde{y}_{t-1} + F_{7,t}i_{t-1} + F_{8,t}i_{t-2} + F_{9,t}i_{t-3} \end{aligned}$$

$f_t$ and $F_{i,t}$ : non-linear functions of $\alpha_t, \beta, \nu, \pi^*, [a_0, a_1, a_2, a_3]$, $[b_0, b_1, b_2, b_3, b_4]$

# Why not inflation target?

Important to clearly define inflation target

1. **Unconditional Inflation Target**: Inflation that the central bank would want if the other variables in the loss functions were equal to their targets
2. **Conditional Inflation Target**: Inflation that the central bank actually chooses, either directly or indirectly by setting the interest rates

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$\Rightarrow$ Change in **2** is compatible with the setup in this paper.

Large changes in **1** are unreasonable:

- Large unconditional inflation target means central bank wants high inflation even when output gap is small.

# Why not inflation target?

In this model

Changes in unconditional inflation target ($\pi^*$)

- Only affect the constant term of the interest rate rule
- Response to output and inflation unchanged

Changes in preference weight ($\alpha_t$)

- Affect both the constant term and the responses

$$\begin{aligned} i_t &= f(\alpha_t, \pi^*) + F_1(\alpha_t)\pi_t + F_2(\alpha_t)\pi_{t-1} + F_3(\alpha_t)\pi_{t-2} + F_4(\alpha_t)\pi_{t-3} \\ & F_5(\alpha_t)\tilde{y}_t + F_6(\alpha_t)\tilde{y}_{t-1} + F_7(\alpha_t)i_{t-1} + F_8(\alpha_t)i_{t-2} + F_9(\alpha_t)i_{t-3} \end{aligned}$$

# Estimation

Bayesian Estimation

- Treat parameters as random variables
- Estimate the posterior distribution of the parameters, i.e. distribution of the parameters conditional on the data.

Markov Chain Monte Carlo Algorithm

- Breaks down high dimensional joint posterior into more manageable conditionals
- Provides numerical samples to approximate the posterior distribution

Extended Kalman Filter

- Non-linear filtering algorithm to estimate unobservable time-varying preference parameter

# Estimation Setup

$$\tilde{y}_t = a_0 + a_1 \tilde{y}_{t-1} + a_2 \tilde{y}_{t-2} + a_3 \left[ \bar{\imath}_{t-1} - \bar{\pi}_{t-1} \right] + g_t$$

$$\pi_t = b_0 + b_1 \pi_{t-1} + b_2 \pi_{t-2} + b_3 \pi_{t-3} + (1 - b_1 - b_2 - b_3) \pi_{t-4} + b_4 \tilde{y}_{t-1} + v_t$$

$$\begin{aligned} i_t = f_t + F_{1,t} \pi_t + F_{2,t} \pi_{t-1} + F_{3,t} \pi_{t-2} + F_{4,t} \pi_{t-3} + F_{5,t} \tilde{y}_t + F_{6,t} \tilde{y}_{t-1} \\ + F_{7,t} i_{t-1} + F_{8,t} i_{t-2} + F_{9,t} i_{t-3} + e_t \end{aligned}$$

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Rewrite the above equations as a VAR

$$A_{0,t} y_t = A_{1,t} + A_{2,t} y_{t-1} + A_{3,t} y_{t-2} + A_{4,t} y_{t-3} + A_{5,t} y_{t-4} + \Psi_t L \varepsilon_t$$

$$\text{where} \quad y_t \equiv \left[ \pi_t, \tilde{y}_t, i_t \right]' ,$$

# Estimation Setup

$$A_{0,t}y_t = A_{1,t} + A_{2,t}y_{t-1} + A_{3,t}y_{t-2} + A_{4,t}y_{t-3} + A_{5,t}y_{t-4} + \Psi_t L\varepsilon_t$$

$$\alpha_t = \alpha_{t-1} + v_t \qquad v_t \sim N(0, Q)$$

Random Walk: Flexible, parsimonious way to uncover potentially permanent shifts in preferences

$$\Psi_t = \begin{bmatrix} \sigma_{1,t} & 0 & 0 \\ 0 & \sigma_{2,t} & 0 \\ 0 & 0 & \sigma_{3,t} \end{bmatrix}, \; L = \begin{bmatrix} 1 & 0 & 0 \\ l_{2,1} & 1 & 0 \\ l_{3,1} & l_{3,2} & 1 \end{bmatrix}$$

$\sigma_{i,t} = \sigma_{i,1}$ for the pre-1984:Q1 sample
$\sigma_{i,t} = \sigma_{i,2}$ for the post 1984:Q1 sample.

# Estimation Setup

$$y_t = h(\alpha_t, X_t, \Gamma, \varepsilon_t) \qquad \varepsilon_t \sim N(0, I) \tag{1}$$

$$\alpha_{t+1} = \alpha_t + v_{t+1} \qquad v_t \sim N(0, Q) \tag{2}$$

where $h(\alpha_t, X_t, \Gamma\varepsilon_t) =$

$B_{1,t} + B_{2,t}y_{t-1} + B_{3,t}y_{t-2} + B_{4,t}y_{t-3} + B_{5,t}y_{t-4} + A_{0,t}^{-1}L\Psi_t\varepsilon_t$

and $\Gamma = [\delta, \nu, L, \Psi_t]$

# Extended Kalman Filter

$$\begin{aligned} y_t &= h(\alpha_t, X_t, \Gamma, \varepsilon_t) & \varepsilon_t \sim N(0, I) \\ \alpha_{t+1} &= \alpha_t + v_{t+1} & v_t \sim N(0, Q) \end{aligned}$$

Extended Kalman Filter

- Linearizes $h(.)$ at each $t$ around $\alpha_{t|t-1}$
- Performs poorly when non-linearities are "severe"

# Extended Kalman Filter

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\end{aligned}
$$

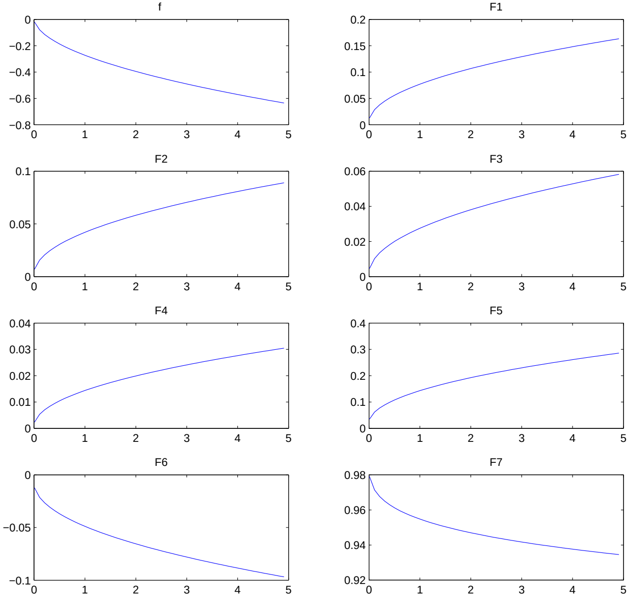
Extended Kalman Filter

- Linearizes $h(.)$ at each $t$ around $\alpha_{t|t-1}$
- Performs poorly when non-linearities are "severe"

$\Rightarrow$ In this model the non-linear function is "quite" linear.

$$i_t = f(\alpha_t, \delta, \nu) + F_1(\alpha_t, \delta, \nu)\pi_t \ldots + F_5(\alpha_t, \delta, \nu)\tilde{y}_t \ldots + F_9(\alpha_t, \delta, \nu)i_{t-3}$$

# Extended Kalman Filter



# Priors

$$\begin{aligned}
\delta &\sim N(\delta_{OLS}, 10.V_{\delta,OLS}) \\
\sigma_{i,t} &\sim IG(2,1) \\
L &\sim N(0,10) \\
Q &\sim U(0,\infty) \\
\nu &\sim U(0,\infty)
\end{aligned}$$

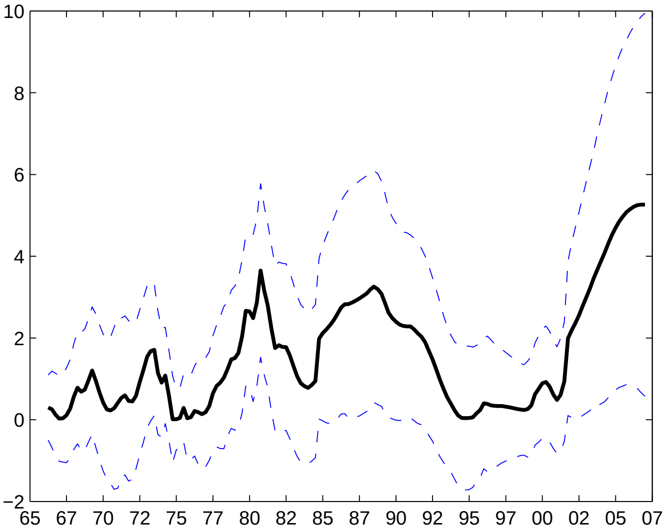



Figure: Time-varying weight on inflation with one standard deviation confidence intervals.

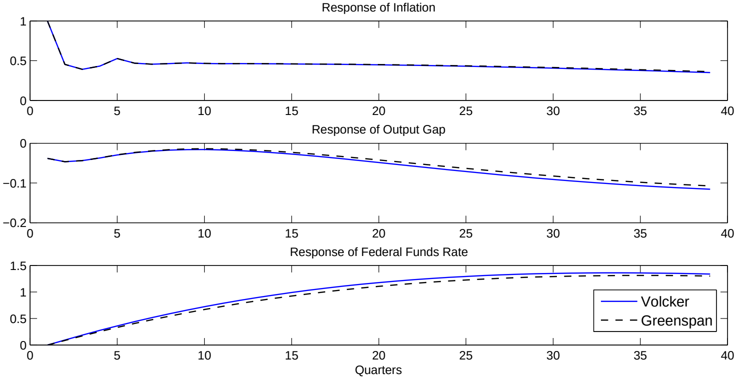



Figure: Impulse responses to a one unit shock in inflation. The solid blue line shows the responses averaging the preferences estimated under Volcker's tenure, while the dashed green line shows the responses averaging the preferences estimated under Greenspan's tenure.

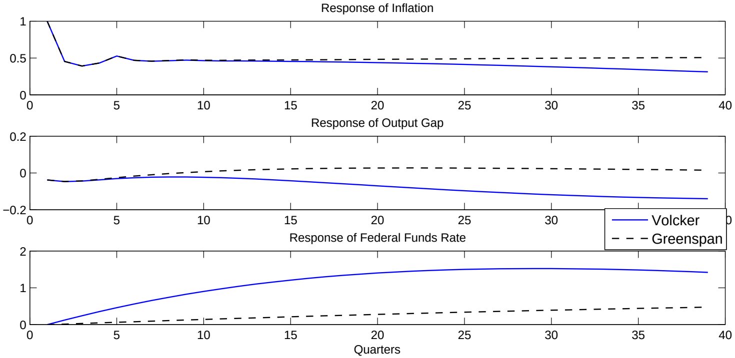
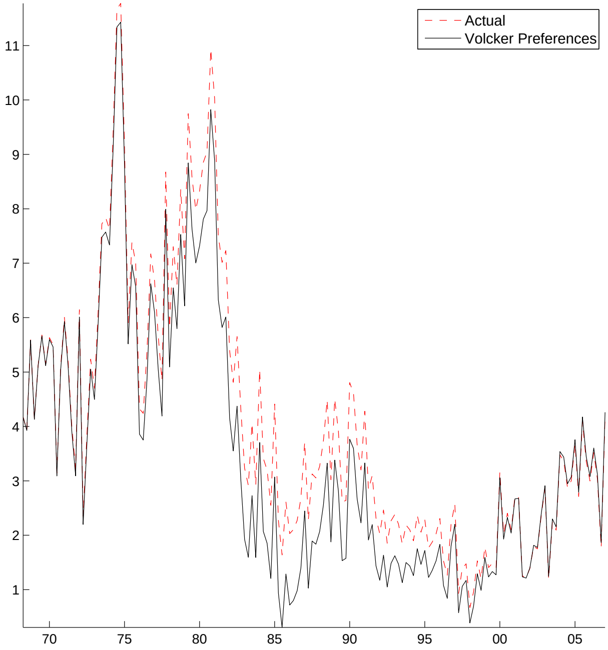



Figure: Impulse responses to a one unit shock in inflation. The solid blue line shows the responses using the highest value of preferences estimated under Volcker's tenure, while the dashed green line shows the responses using the lowest value of preferences estimated under Greenspan's tenure.

**Would "appointing" Volcker early have avoided the Great Inflation?**

Construct counterfactual series of inflation

- Monetary policy in the 1970s is conducted with "Volcker's preferences" (average over his first term)
- Shocks hitting the economy stay the same



Actual
Volcker Preferences
11
10
9
8
7
6
5
4
3
2
1
70
75
80
85
90
95
00
05

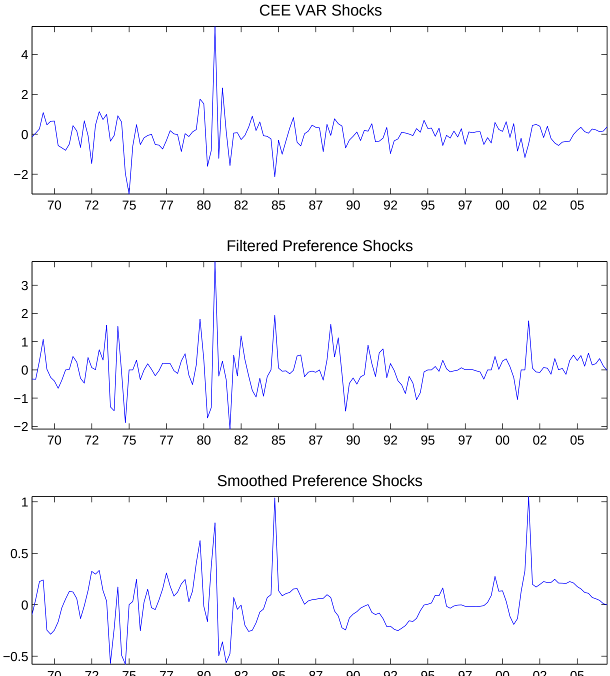
## A New Measure of Monetary Policy Shock

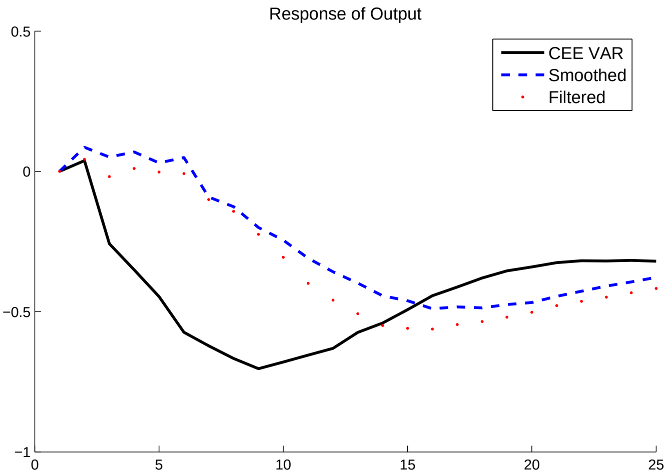
# A New Measure of Monetary Policy Shock

Christiano, Eichenbaum & Evans (1999)

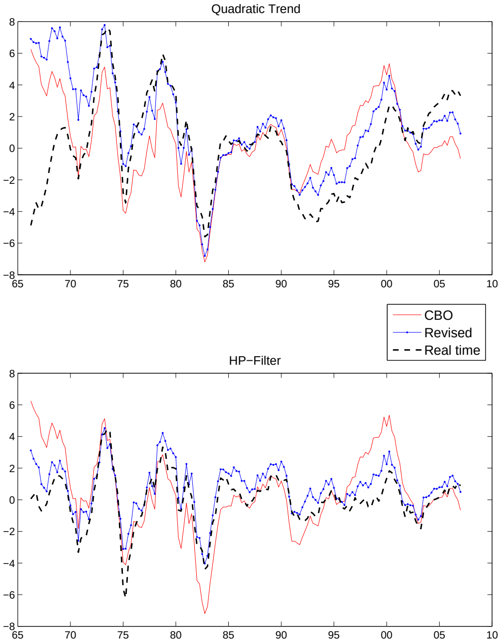
*"... exogenous shocks to the preferences of the monetary authority, perhaps due to stochastic shifts in the relative weight given to unemployment and inflation."*

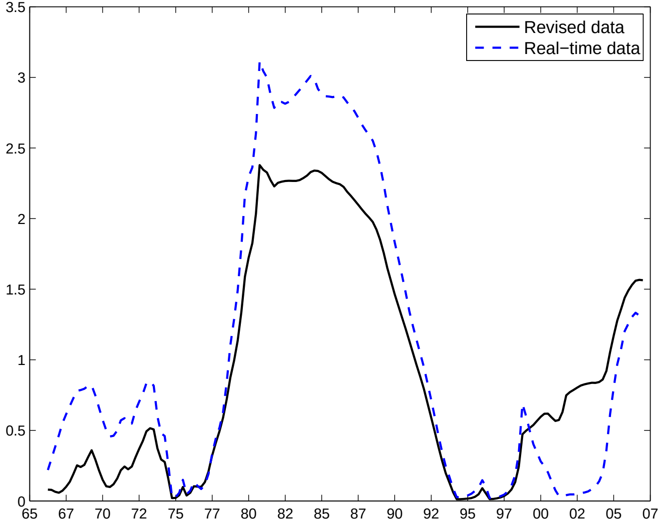
$$\hat{v}_t = \alpha_t - \alpha_{t-1}$$


CEE VAR Shocks
Filtered Preference Shocks
Smoothed Preference Shocks
70
72
75
77
80
82
85
87
90
92
95
97
00
02
05



Response of Output
CEE VAR
Smoothed
Filtered
0.5
0
−0.5
−1
0
5
10
15
20
25


Quadratic Trend
8
6
4
2
0
−2
−4
−6
−8
65
70
75
80
85
90
95
00
05
10
CBO
Revised
Real time
HP−Filter
8
6
4
2
0
−2
−4
−6
−8
65
70
75
80
85
90
95
00
05
10



Revised data
Real−time data
3.5
3
2.5
2
1.5
1
0.5
0
65
67
70
72
75
77
80
82
85
87
90
92
95
97
00
02
05
07

| Standard Deviations | | | |
|---|---|---|---|
| | Inflation | Output Gap | Fed Funds Rate |
| Data | | | |
| pre 1984:Q1 | 2.284 | 3.298 | 3.617 |
| post 1984:Q1 | 0.964 | 1.807 | 2.410 |
| % fall: pre to post | 0.578 | 0.452 | 0.334 |
| Model | | | |
| pre 1984:Q1 | 1.981 | 3.228 | 3.658 |
| post 1984:Q1 | 0.744 | 1.727 | 2.412 |
| % fall: pre to post | 0.624 | 0.465 | 0.340 |
| Counterfactual (No SV) | | | |
| pre 1984:Q1 | 2.288 | 3.299 | 3.725 |
| post 1984:Q1 | 1.759 | 3.738 | 4.495 |
| % fall: pre to post | 0.231 | -0.133 | -0.207 |
| Counterfactual (No Preference Change) | | | |
| pre 1984:Q1 | 2.234 | 3.283 | 2.833 |
| post 1984:Q1 | 0.901 | 1.781 | 1.777 |
| percent fall: pre to post | 0.597 | 0.458 | 0.373 |

Table: Counterfactual Standard Deviations

# Conclusion

- Fed preferences have varied in a gradual complex manner
- "Volcker-style" preferences would have lowered but not avoided high inflation episode of 1970s
- New measure of monetary policy shock gives effects on the economy similar to VAR literature
- Neither preferences nor size of shocks can completely account for Great Moderation

# Thank you

# Example: Simple Model

$$
\begin{aligned}
x_{t+1} &= c_1 x_t - c_2(i_t - \pi_t) + u^d_{t+1} \\
\pi_{t+1} &= \pi_t + c_3 x_t + u^d_{t+1}
\end{aligned}
$$

Loss function for central bank

$$L = \frac{1}{2}\left\{\sum_{t=0}^{\infty} \beta^t \left[(\pi_t - \pi^*)^2 + \lambda x_t^2\right]\right\}$$

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Optimal interest rate rule

$$i_t = \pi_t + B(\pi_t - \pi^*) + C x_t$$

where $B = \left[1 - \left(\dfrac{\lambda}{\lambda + \beta k (c_3)^2}\right)\right](c_2 c_3)^{-1}$