On the Limits of Monetary Policy

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†The views expressed are those of the authors and do not necessarily reflect the position of the Federal Reserve Bank of Dallas or the Federal Reserve System.

Motivation

Long-standing debate on activist stabilization policy

- Monetarist controversies of the 1970s centered on ability to: assess accurately the state of the economy; formulate reliable forecasts; calibrate the impact of policy
- Subsequent decades rising optimism about the efficacy of policy

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- Subsequent decades rising optimism about the efficacy of policy

Reflected in academic research

- Policy is powerful: e.g. can largely eliminate inefficient fluctuations — Clarida, Gali and Gertler (1999), Justiniano, Primiceri and Tambalotti (2013), Furlanetto, Gelain and Sanjani (2017), Challe (2017)
- But if so: why hasn't monetary policy eliminated business cycles?

Our Thesis

Monetary policy transmission mechanism

$\Longrightarrow$ link between policy rate and long-term interest rates

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$\Longrightarrow$ link between policy rate and long-term interest rates

$\Longrightarrow$ link between policy rate and expected future policy rate

Our Thesis

Power of policy rests on anchored long-term expectations

Anchored expectations [Full Information Rational Expectations]

- Changes in policy rate efficiently transmitted along the term structure of interest rates
- Long-run expectations pinned down: room to run counter-cyclical stabilization policy
- Short-term activist policy is feasible

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Poorly anchored expectations [Distorted long-run beliefs]

- Long-term expectations show 'excess sensitivity' to short-run developments
- Policy trade-off: aggressive short-term stabilization induces volatility in long-term rates
- Limits what monetary policy can do, even when central bank fully informed about the economy

Contributions: Model

- Anchoring: distorted beliefs in which agents have imperfect information about long-run economic fundamentals
  - Agents believe long-run means are time-varying and use Kalman filter to adjusts expectations
  - Link between LT expectations and short-term forecast errors (structural shocks)
- Embed in New Keynesian model: 'extrapolation bias' as an equilibrium outcome (Fuster, Leibson and Mendel, 2010)
  - Forecasts excessively influenced by short-term changes
  - Subjective beliefs more persistent than objective beliefs
- Wedge between subjective and objective beliefs is time-varying and endogenous to monetary policy and identified shocks

Contributions: Policy

- **Theory**: Optimal policy *more 'activist'* when long-run expectations are stable (anchored) and *less 'activist'* when long-run expectations are less stable
  - Full stabilization in response to efficient fluctuations *infeasible*

- **Empirical**: information friction + monetary policy shocks key to explaining low frequency behavior of US inflation and output gap

- Information friction introduces quantitatively important trade-off for optimal policy
  - Improves on historical policy but considerably less effective than optimal policy under rational expectatios

Some Context

Bounded rationality and learning on policy design

- Orphanides and Williams (2005), Ferrero (2007), Molnar and Santoro (2013), ...
- Monetary authority has tight control on aggregate demand.Focus on inflation expectations and aggregate supply.
- Optimal policy under learning *more aggressive* toward inflation relative to rational expectations.
- <u>This paper</u> deals with the monetary policy transmission channel: MP is *less active* relative to rational expectations.

Optimal policy under central banks' limited information

- Long tradition: Friedman (1968), Modigliani (1977) and Meltzer (1987), Orphanides (2001), Svensson and Woodford (2003), Orphanides and Williams (2012),...
- <u>This paper</u>: central bank has the correct model of the economy but imperfect information on the output gap

Some Context

Optimal policy under alternative information frictions

- **Rational inattention**: Paciello and Wiederholt (2013), Adam (2007)...
- **Noisy information**: Lorenzoni (2010), Angeletos and La'O (2020),...
- **Robust control**: Woodford (2010),...
- **Bounded rationality**: Gabaix (2020)...

- This paper:
  1. Effects of informational frictions on the monetary transmission mechanism: link between short-term and long- term interest rate
  2. Above papers generally find full stabilization is always achievable even if not always desirable. *In our framework full stabilization is desirable but not feasible*.

A Simple Economy

- Aggregate demand and supply equations

$$
\begin{aligned}
x_t &= \hat{E}_t \sum_{T=t}^{\infty} \beta^{T-t} \left[(1-\beta) x_{T+1} - (R_T - \pi_{t+1} - r_T^n) \right] \\
\pi_t &= \hat{E}_t \sum_{T=t}^{\infty} (\alpha\beta)^{T-t} \left[\kappa x_T + (1-\alpha) \beta \pi_{T+1} \right]
\end{aligned}
$$

- r_t^n exogenous
- $\hat{E}_t$ denotes subjective expectations

A Simple Economy II

The transmission mechanism of monetary policy

$$x_t = -\beta R_t + \hat{E}_t^i \sum_{T=t}^{\infty} \beta^{T-t} \left[(1-\beta) x_T - \beta \left(\beta R_{T+1} - \pi_{T+1} - r_T^n \right) \right]$$

- Precise control of current R_t; imprecise control of $\hat{E}_t^i R_T$ for $T > t$
- Connection between these objects endogenously determined and regulated by information friction

Monetary Policy

Central bank minimizes the loss function

$$\mathcal{L}_t = E_t \sum_{T=t}^{\infty} \beta^{T-t} \pi_T^2$$

- E_t denotes *objective* (model consistent) expectations
- Optimal policy is the targeting criterion $\pi_t = 0$.
- Implement using implicit instrument rule

$$\begin{aligned} R_t \quad = \quad & r_t^n + \hat{E}_t \sum_{T=t}^{\infty} (\alpha\beta)^{T-t} \left[\alpha\beta \cancel{x_{T+1}} + (1-\alpha)\beta\kappa^{-1} \cancel{\pi_{T+1}} \right] + \\ & + \hat{E}_t \sum_{T=t}^{\infty} \beta^{T-t} \left[(1-\beta)\cancel{x_{T+1}} - \left(\beta \cancel{R_{T+1}} - \cancel{\pi_{T+1}} - \beta r_{T+1}^n \right) \right] \end{aligned}$$

Rational Expectations

- Equilibrium: $x_t = \pi_t = 0$ in every period
- The implicity instrument rule reduces to

$$R_t = r_t^n$$

- Monetary policy aggressively tracks current and expected changes in the natural rate
- For $T > t$ expected path of R_T moves in lock-step with the expected path for r_T^n
- For this example make r_t^n i.i.d. so expected R_T is constant

Information Friction

In the long-run: $\bar{\pi}_t =?$; $\bar{r}_t =?$

- Model with 'shifting end-points' —Kozicki and Tinsley (2001)

$$\begin{bmatrix} R_t \\ \pi_t \end{bmatrix} = \bar{\omega}_{t-1} + e_t$$

$$\bar{\omega}_t = \bar{\omega}_{t-1} + u_t$$

  - e_t and u_t are i.i.d. with variances R and Q, with $Q = \bar{g}^2 R$
  - Use Kalman filter to learn about unobserved drift, $\bar{\omega}_t$
  - REE $\Rightarrow \bar{\omega}_t = 0$.

Belief Updating

- Beliefs revised according to

$$\omega_{t+1}^{\pi} = \omega_t^{\pi} + \bar{g}(\pi_t - \omega_t^{\pi})$$
$$\omega_{t+1}^{R} = \omega_t^{R} + \bar{g}\left(R_t - \omega_t^{R}\right)$$

- The learning gain $\bar{g}$ regulates the information friction

  $\Rightarrow$ measures *perceived* volatility of the unobserved drift $\bar{\omega}_t$ relative to short-term noise,

Equilibrium Dynamics

To implement the inflation target, $\pi_t = 0$

$$\boxed{R_t = r_t^n} + \underbrace{\left(\frac{1}{1-\beta} + \frac{(1-\alpha)\,\beta\kappa^{-1}}{1-\alpha\beta}\right)\omega_t^\pi - \frac{\beta}{1-\beta}\omega_t^R}_{\text{Information friction}}$$

Beliefs evolve as

$$\omega_{t+1}^\pi = (1-\bar{g})\,\omega_t^\pi$$

$$\omega_{t+1}^R = \underbrace{\left(1 - \frac{\bar{g}}{1-\beta}\right)}\omega_t^R + \bar{g}\left(\frac{1}{1-\beta} + \frac{(1-\alpha)\,\beta\kappa^{-1}}{1-\alpha\beta}\right)\omega_t^\pi + \bar{g}\,r_t^n$$

- LT beliefs respond to shocks for $\bar{g} > 0$: degree of anchoring
- Optimal policy *unfeasible* unless

$$\bar{g} > 2(1-\beta)$$

Implementable Rules

- Consider using the policy rule

$$R_t = \phi \pi_t$$

- Stable equilibrium requires

$$\bar{g} < \frac{2(1-\beta)}{1-\phi^{-1}}$$

Extrapolation Bias

The wedge between subjective and objective beliefs can be written

$$
\begin{aligned}
\hat{E}_t R_T - E_t R_T &= \left(1 - \frac{\phi^{-1} - \beta}{1 - \beta}\right) \omega_t^R \\
&= \bar{g} \times \left(1 - \frac{\phi^{-1} - \beta}{1 - \beta}\right) \sum_{j=0}^{\infty} \left(1 - \bar{g}\frac{1 - \phi^{-1}}{1 - \beta}\right)^j r_{t-1-j}^n
\end{aligned}
$$

The stance of policy matters for both size and persistence:

- For empirically relevant parameters: $0 < \left(1 - \bar{g}\frac{1-\phi^{-1}}{1-\beta}\right) < 1$ lower ϕ increases the wedge's persistence
- Higher $\bar{g}$ increases size but lowers persistence

The Role of Aggregate Demand

Suppose the central bank controls aggregate demand directly. Then we have the model

$$\begin{aligned}\pi_t &= 0 \\ \pi_t &= \kappa x_t + \frac{(1-\alpha)\beta}{1-\alpha\beta}\omega_t^\pi.\end{aligned}$$

Because the inflation target is enforced in every period, the evolution of inflation beliefs is

$$\omega_{t+1}^\pi = (1-\bar{g})\,\omega_t^\pi,$$

- Stable for all parameters
- Key role for information friction in monetary transmission mechanism

The Information Friction

Consistent with

- **Extrapolation bias and natural expectations**
  — Fuster, Laibson and Mendel (2010), Cieslak (2018), Landier, Ma, Thesmar (2018)
- **Tight link between surprises and long-term expectations**
  — Carvalho, Eusepi, Moench and Preston (2019)
- **Estimates of long-run concepts such as potential output affected by business cycle shocks**
  — Coibion, Gorodnichenko and Ulate (2018)
- **Over-sensivity of long-term rates to news**
  — Gurkaynak, Sack and Swansson (2005), Nakamura and Steinsson (2017), Crump, Eusepi and Moench (2017)
- **Behavioral theories**
  — Bordalo, Gennaioli, Ma and Shleifer (2018), A. da Silveira, Sung and Woodford (2019)

The Policy Trade-off

Standard view. Aggressive monetary policy (towards inflation) provides nominal anchor by stabilizing inflation expectations

- Clarida, Gali and Gertler (1999), Schmitt-Grohe and Uribe (2007), Orphanides and Williams (2005), Ferrero (2007), Molnar and Santoro (2013)
- Do not consider loose monetary transmission

Our view. Aggressive monetary policy (towards inflation) can lead to instability.

- Degree of active intervention depends on anchoring of expectations

DSGE Model

Standard medium-scale New Keynesian model

- No money; fixed capital stock
- Monopolistic competition
- Staggered price-setting in goods and labor markets
- Indexation in goods and labor markets
- Internal habit formation

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Beliefs

- Same friction as simple model except

$$
\begin{aligned}
z_t &= S\bar{\omega}_{t-1} + \Phi z_{t-1} + e_t \\
\bar{\omega}_t &= \rho\bar{\omega}_{t-1} + u_t
\end{aligned}
$$

- Only information frictions in LT beliefs; $\underline{\bar{\omega}_t = 0}$ delivers rational expectations

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- Linear state space representation: estimation using standard likelihood-based methods

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Policy

- **Fiscal**: agents are Ricardian; zero debt; balanced budget
- **Monetary**:

$$R_t = \rho_R R_{t-1} + (1 - \rho_R) \left(\phi_\pi \pi_t + \phi_x x_t^{CB} + \phi_{\Delta x} \Delta x_t^{CB} \right) + \varepsilon_{M,t}$$

Bayesian Estimation

Sample

- Quarterly data 1964Q1-2007Q3

Observables standard

- GDP deflator, TBill 3 months, CBO output gap (de-trended output), NIPA and BLS nominal wage growth
- Use Orphanides real-time output gap estimate to quantify mismeasurement

$$x_t^{CB} = x_t + \nu_t$$

Observables to discipline expectations

- 1Q+4Q SPF interest rate (1981Q3) and inflation (1968Q3)
- 1-10 year and 5-10 year interest rate (1985Q1) and inflation (1979Q3), Blue Chip Economics and Financial

Bayesian Estimation II

Shocks – AR(1)

1. **Efficient fluctuations–natural rate**: government spending; labor preferences; technology
2. **Markup**: price and wages (i.i.d)
3. **Monetary policy**: conventional (i.i.d.), output gap "measm. error"

Measurement error – i.i.d

- All survey data
- The two measures of wages

Bayesian Estimation III

Sensitivity of LT beliefs to short-term forecast errors depends on

- Size of shocks
- Monetary policy regime
- Learning gain

Three known regimes

- **Regimes 1 and 2**: 1964Q1-1979Q3 and 1984Q1-2007Q3
  - Allow for variation in policy parameters and shock volatilities
- **Regime 3**: Q1 1999
  - Structural break in sensitivity of long-run beliefs [Cavalho, Eusepi, Moench and Preston 2020]

Parameter Estimates I: Regime Change

Shock volatility

- Clear evidence of fall in volatility of 40% on average

Policy rule

- Little evidence of a change in policy regime: modest rise in inflation response
  - consistent with Primiceri (2005), Justiniano and Primiceri (2008) and Sims and Zha (2006), ...
- No strong evidence of a less aggressive output gap response as opposed to Orphanides (2003) and Orphanides and Williams (2005)

Beliefs

- Clear evidence of a fall in gain coefficient and the anchoring of expectations

Parameter Estimates II: Summary

1. Low EIS of consumption (< 0.2)
2. Significant nominal rigidities: Wage Phillips curve considerably flatter than Price Phillips curve
3. Policy rule with high degree of inertia and weaker response to inflation than standard Taylor rule
4. Kalman gain: $g = 0.05$ (precisely estimated) in early regime
   - significant degree of extrapolation from recent changes
   - 40%(10%) weight 5(10) years-old observations.

Results: A Road Map

1. Basic model properties and fit
2. The role of information frictions
3. The role of monetary policy shocks in the Great Inflation
4. Optimal policy counterfactuals

Drifting Expectations: Inflation

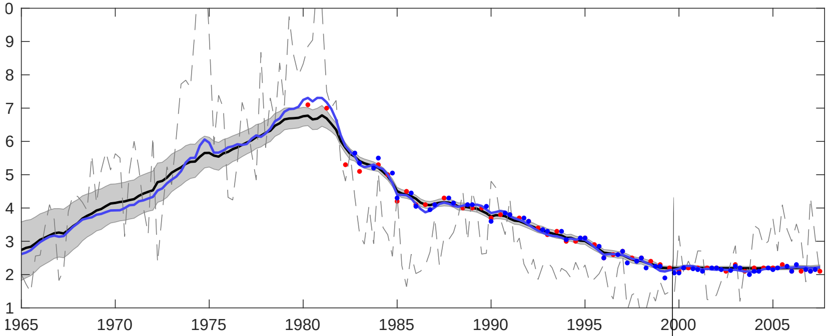

Figure: Model implied 5-10 year inflation forecasts (solid black); 1-10 year (blue); survey data (dots); actual inflation (black dashed)

- Small measurement error: tight connection between short-run forecast errors and long-term forecasts
- Drift captures low-frequency movement

Drifting Expectations: Real Rates

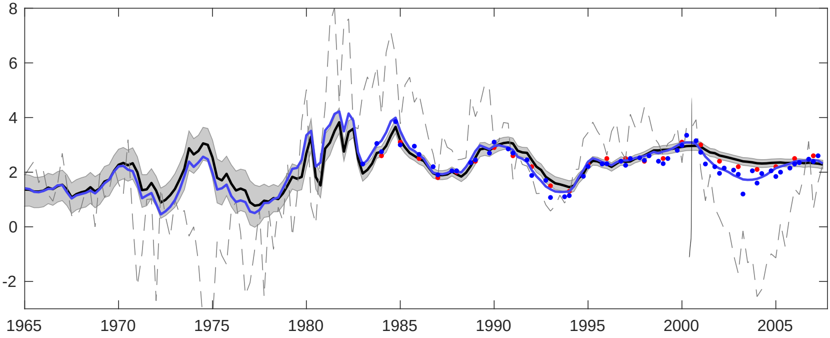

Figure: Model implied 5-10 year real rate forecasts (solid black); 1-10 year (blue); survey data (dots); actual ex post short real rate (black dashed)

- Independent evidence of drift in the real rate
- Until 2000, driven by ω_t, not by shocks' persistence

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Subjective versus Objective Beliefs

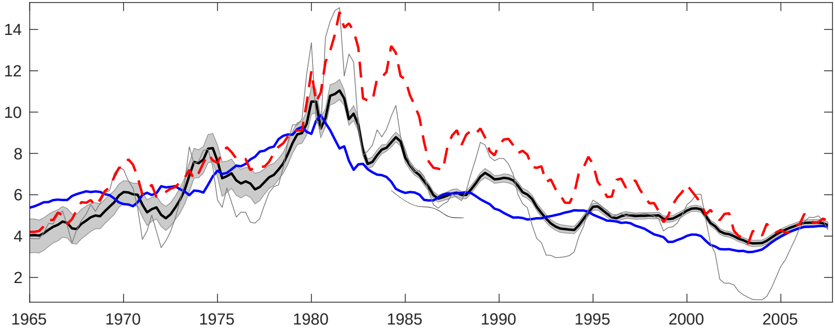


Figure: 3-month TBill (dashed); 10Y Yield with subjective beliefs (solid black); 10Y Yield with model consistent beliefs (solid blue)

- Sluggish adjustment of expectations over the 1980s relative to ‘model consistent’ expectations hypothesis
- ‘Subjective’ yields more volatile and stronger co-movement with short-term rate and bond yields

Subjective versus Objective Beliefs

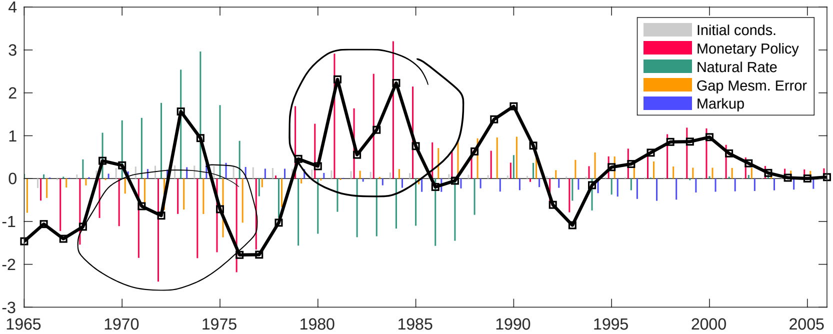
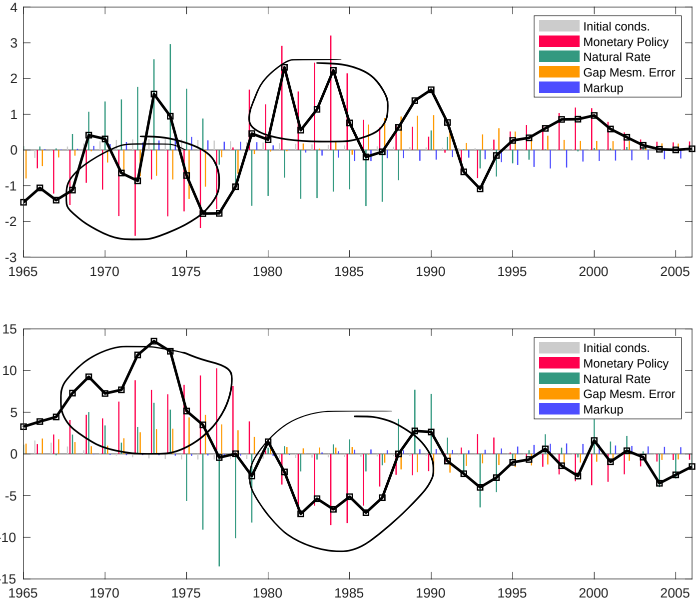


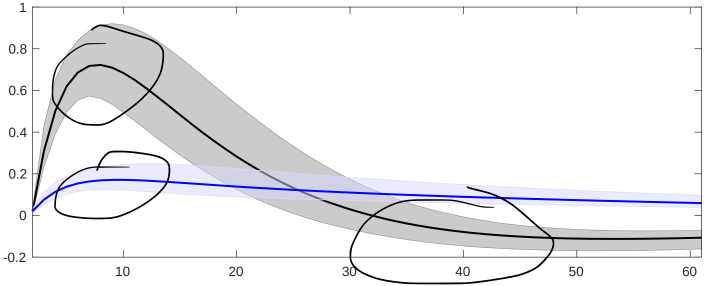
Figure: Discrepancy between 10 year yields priced under subjective and objective beliefs

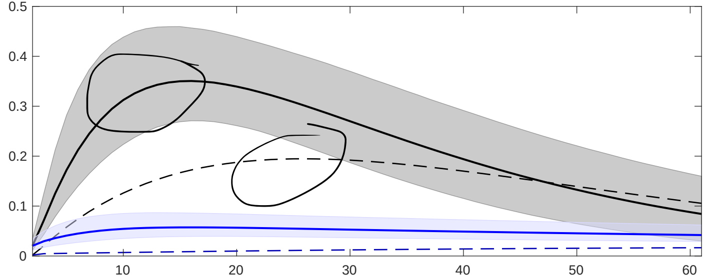
- The wedge accounted for by monetary policy shocks

Subjective versus Objective Beliefs: wedge and output gap

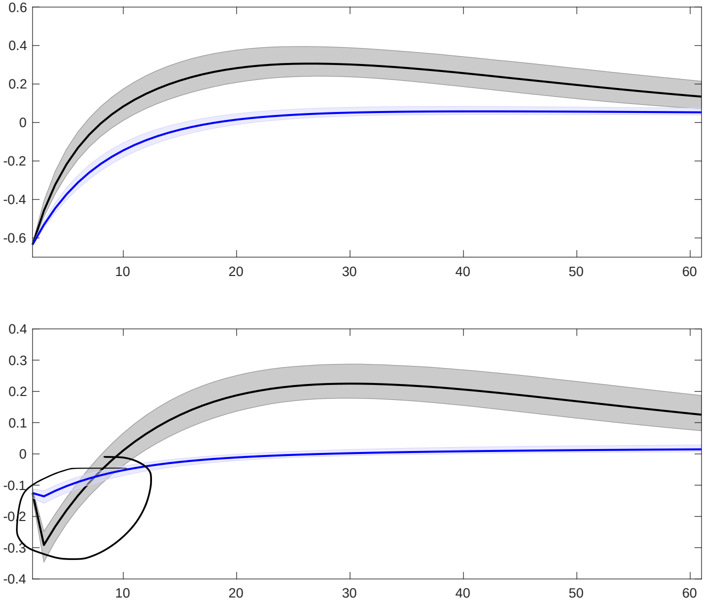


MP shock: Output and Inflation





MP shock: Policy Rate and 10-year-yield



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The Role of Monetary Policy Shocks

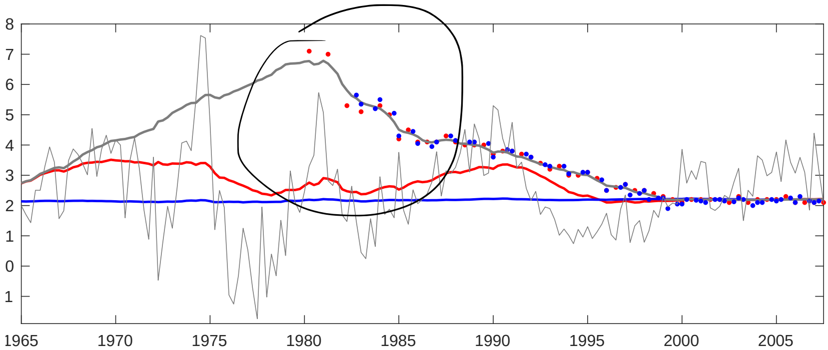

Figure: 5-10 year inflation forecasts. Benchmark model (grey); survey data (dots); no monetary policy shocks (red); rational beliefs (blue); 95 percent credible set (grey)

- Information friction + monetary shocks = Great Inflation

The Role of Monetary Policy Shocks

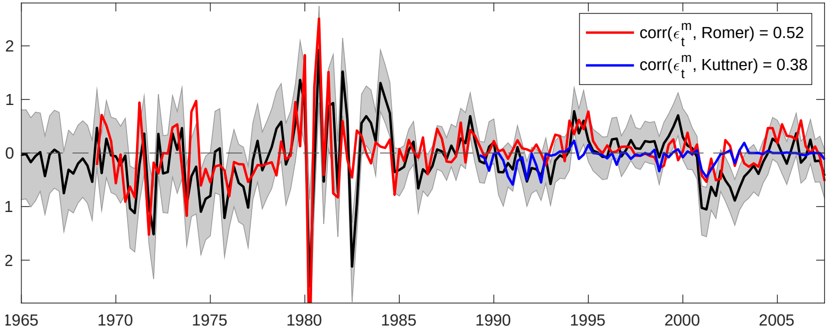

Figure: Monetary policy rule shocks. Benchmark model (black); 95 percent credible set (grey)

- Plausible estimates of monetary shocks; consistent with conventional narratives

The Role of Monetary Policy Shocks

	Short-Term			Long-Term		
	1964-1983	1984-1998	1999-2007	1964-1983	1984-1998	1999-2007
Inflation	0.7	0.8	0.1	37.8	45.1	5.5
	(0.3,1.9)	(0.3,2.7)	(0.0,0.3)	(26.4,50.2)	(32.0,58.0)	(2.6,11.8)
Output	9.5	11.8	0.9	38.6	48.2	19.6
	(5.6,15.2)	(7.3,19.7)	(0.4,2.0)	(26.9,50.9)	(37.8,58.1)	(12.3,29.5)
10-year R	39.3	48.9	47.3	50.8	59.6	37.9
	(27.0,52.3)	(35.8,62.1)	(32.6,63.6)	(35.8,64.2)	(47.4,69.9)	(24.4,54.7)

Figure: Short-term is the $1-4$ quarters average; long-term is the $36-100$ quarters average

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Optimal Policy Problem

- Rational policy maker minimizes welfare-theoretic loss

$$E_t \sum_{T=t}^{\infty} \beta^{T-t} L_T$$

where in this model

$$L_t = \lambda_p \left(\pi_t - \iota_p \pi_{t+1}\right)^2 + \lambda_w \left(\pi_t^w - \iota_w \pi_{t-1}\right)^2 + \lambda_x \left(x_t - \bar{b} x_{t-1}\right)^2$$

- Look for optimal policy
  - Subject to the constraints implied by private behavior
  - Subject to private agents' expectations formation (either Rational Expectations or Learning)
  - Within a class of rules

Target Criterion

Choose policy in the class

$$R_t = R_{t-1} + \phi TC_t$$

where the target criterion

$$TC_t \;\;=\;\; \phi_\pi \left(\pi_t - \iota_p \pi_{t-1}\right) + \left(\pi_t^w - \iota_w \pi_{t-1}\right) + \phi_{\Delta x}\left(x_t^{CB} - x_{t-1}^{CB}\right)$$

Optimal policy coefficients under rational expectations

- $\phi^* = \infty$

Optimal policy coefficients under learning

- 1964-1983: $\phi^* = 1.74$
- 1984-1998: $\phi^* = 0.44$
- 1999-2007: $\phi^* = 19.1$

Welfare Losses under Optimal Policy

	$\mathcal{L}$		
	1964-1983	**1984-1998**	**1999-2007**
Historical policy [$\hat{m}_t = 0$]	159.8	65.2	57.2
Optimal Policy	72.5	48.0	37.9
Optimal Policy AD control	9.5	20.7	20.2
Optimal Policy full info	8.6	20.1	20.1

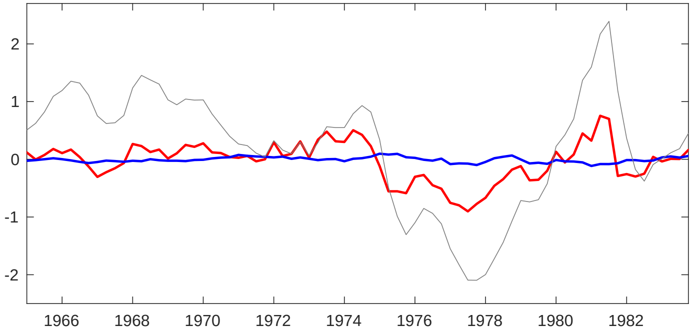
Counterfactual Assumptions

- Same initial state as baseline.
- Same shock sequence.
- Different policy regime: But
  - Same constant gain — policy invariant, though not beliefs.
  - Know new transition dynamics. Remember:

$$z_t = S\omega_t + \Phi z_{t-1} + \Phi_\varepsilon \varepsilon_t$$

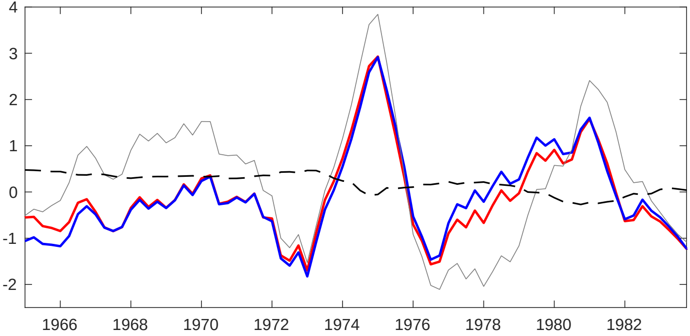
- Interpretation: inhabited the regime since the distant past

Optimal Policy: Wage Inflation



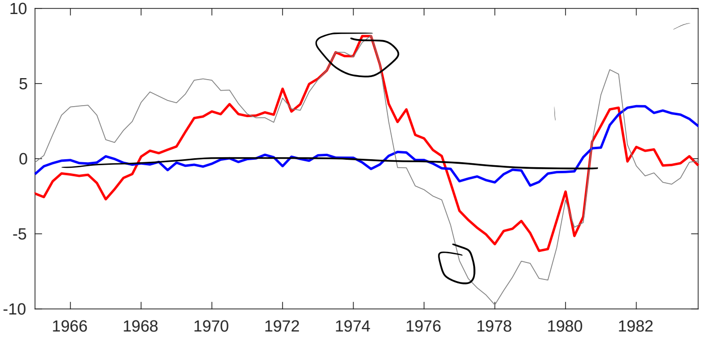
- Greater stabilization of wage inflation under RE
- Complete stabilization of demand shocks infeasible

Optimal Policy: Price Inflation



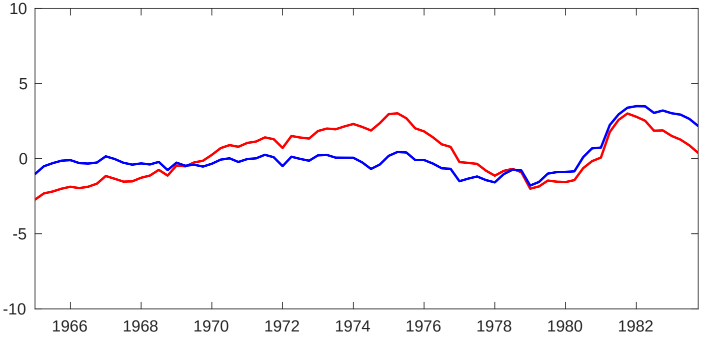
- Less stabilization of price inflation than wage inflation — reflects the relative slopes of the price and wage Phillips curves
- Role of markup shocks

Optimal Policy: Output Gap



- Complete stabilization of demand shocks infeasible
- REE consistent with Justiniano, Tambalotti and Primiceri (2013)

Optimal Policy: Full Control on Aggregate Demand



- Complete stabilization
- REE consistent with Justiniano, Tambalotti and Primiceri (2013)

Conclusion

- Shifting long-term interest-rate expectations constrain what can be achieved by current interest-rate policy
- Aggregate demand a constraint on policy actions — policy less aggressive relative to rational expectations
- Quantitatively important
  - Demand shocks generate non-trivial variation
  - But policy still plays a critical role in proving a nominal anchor