Ambiguity, Monetary Policy and Trend Inflation

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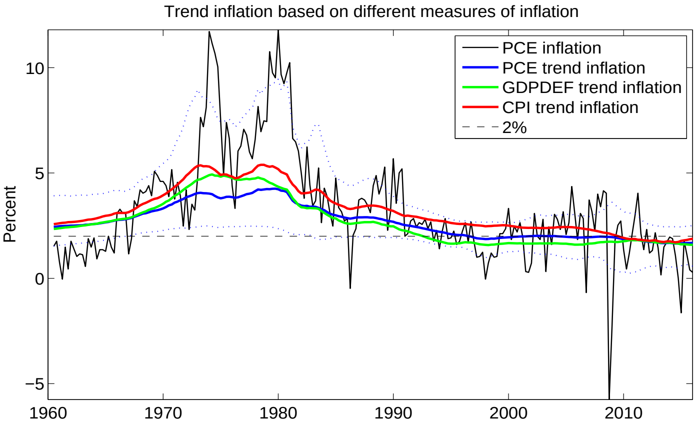
Motivation

- Inflation exhibits low-frequency variations: **inflation trend**
- Low-frequency component:
  - drives inflation dynamics (Stock and Watson, 2007)
  - determines inflation persistence (Cogley and Sbordone, 2008)
- Standard treatment:
  - most models ignore it (log-linearization around zero inflation or full steady-state indexation)
  - or treat variations in the inflation **trend** as variations in the inflation **target**, e.g. Del Negro, Giannoni and Schorfheide (2015).

Trend Inflation



BVAR: Cogley and Sargent (2002) and Cogley and Sbordone (2008)

A Time-Varying Inflation Target?

The Fed announced a 2% PCE inflation target in 2012.

But before:

- Blue Book simulations used a 1.5%-2% target at least since 2000.
- As early as 1996, numerous FOMC members indicated preferences for 2% inflation target (Lindsey, 2003)
- *Chairman Greenspan testified in 1989 in favor of a qualitative zero inflation objective...* (Goodfriend, 2003)
- Orphanides (2002) suggests that "non-inflationary full employment potential" had been the the MP objective since WWII at least.

If not Target Changes, what?

... the faulty estimate [of the Federal Funds Rate] was largely attributable to misapprehensions about the Fed's intentions. [...] Such misapprehensions can never be eliminated, but they can be reduced by a central bank that offers markets a clearer vision of its goals, its 'model' of the economy, and its general strategy.
Blinder (1998)

- If the private sector is not fully confident about the Central Bank's objective and model of the economy inflation can persitently deviate from target:

  Inflation Trend $\neq$ Inflation Target

Confidence and Transparency

SPF 2007Q4

Special questions:

- Do you think the Fed follows a numerical target for long-run inflation ?
- If so, what value?
- Respondents also provided their expectations for inflation over the next 10 years

	Targeters	Non-Targeters
Percentage of Responders	48	46
Average Target	1.74	n.a.
10-yr PCE Inflation Expectation	2.12	2.25
Short-rate Dispersion	.49	.61

Proposed Explanation for Trend Inflation

- We provide a micro-foundation for **trend inflation**, which stems from **ambiguity** regarding the conduct of monetary policy.

- Without resorting to changes in the target or changes in the policy's responsiveness to inflation, our model can explain:

  - the decline in trend inflation in the 80s
  - the below-target trend inflation post Great Recession
  - Paul Volcker's apparent excessive tightening in 1982

Literature

I. Optimal MP design in small NK models. An incomplete list includes:
   - King and Wolman 1996,
   - Schmitt-Grohé and Uribe, 2007
   - Ascari and Ropele, 2007
   - Yun, 2005
   - Galí, 2008

II. Ambiguity:
   - Ilut and Schneider, 2014 (first-order effects of ambiguity)
   - Gilboa and Schmeidler, 1998

III. Ambiguity and Monetary Policy:
   - Cogley, Colacito, Hansen and Sargent, 2008
   - Adams and Woodford, 2012
   - Benigno and Paciello, 2014

The Model

- Standard small New Keynesian DSGE (similar to Galí, 2008 or Yun, 2005):
  - No capital
  - Sticky prices (Calvo 1983)
  - Competitive labor market

- *The private sector is not fully confident about its understanding of the monetary policy rule* (Gilboa and Schmeidler (1998), Epstein and Schneider (2003) and Ilut and Schneider (2014))

More on ambiguity

Households' Problem

The household maximizes:

$$U_t(\overrightarrow{C}; s^t) = \min_{\mu_t \in [\underline{\mu}_t,\ \overline{\mu}_t]} \mathbb{E}^{\mu}\left[u(\overrightarrow{C}_t) + \beta U_{t+1}(\overrightarrow{C}; s_t,\ s_{t+1})\right]$$

$$\text{s.t. } P_t C_t + B_{t+1} = R_{t-1} B_t + W_t N_t + T_t$$

where their felicity is described by:

$$u(\overrightarrow{C}_t) = log[C_t] - \frac{N_t^{1+\psi}}{1+\psi}$$

Household's First-Order Conditions

$$\frac{1}{C_t} = \mathbb{E}_t^{\mu}\left[\frac{\beta R_t}{C_{t+1}\Pi_{t+1}}\right]$$

$$N_t^{\sigma} C_t = \frac{W_t}{P_t}$$

$$\mathbb{E}_t^{\mu}\left[\frac{\beta R_t}{C_{t+1}\Pi_{t+1}}\right] \equiv \mathbb{E}_t\left[\frac{\beta \tilde{R}_t}{C_{t+1}\Pi_{t+1}}\right]$$

Hence the intertemporal Euler equation becomes:

$$\frac{1}{C_t} = \mathbb{E}_t\left[\frac{\beta \tilde{R}_t}{C_{t+1}\Pi_{t+1}}\right]$$

Monetary Policy

The Central Bank follows:

$$R_t = (R_t^n e^{\varepsilon_t})(\Pi_t)^{\phi}, \quad (1)$$

where $R_t^n = \mathbb{E}_t \frac{A_{t+1}}{\beta A_t}$ is the natural rate and ε_t is characterized by the following law of motion:

$$\varepsilon_t = \rho^{\varepsilon} \varepsilon_{t-1} + u_t^{\varepsilon} + \mu_t^{*}. \quad (2)$$

- This rules, together with the subsidy, implements the first best steady state
- If it wasn't for ε_t this rule would implement first best at all times

Timing

1. At the beginning of time t, when decisions are made, the realization of ε_t is not yet known, so the household's expected policy rate (in logs) is:

$$\mathbb{E}_t^{\mu_t} r_t = r_t^n + \rho^\varepsilon \varepsilon_{t-1} + \mu_t + \phi \pi_t .$$

2. Consumption will be pinned down so that desired savings are zero, given this expectation for the policy rate.
3. When the actual policy rate is set it will not affect the household's wealth, because bonds holdings are zero.

Firms' Problem   Government

Steady-State

The interest rate used for decision-making purposes is not the one set by the CB

$$\downarrow$$

Inflation will not hit the first-best level (in logs)

$$\overline{\pi} = \pi^* - \frac{\mu}{\phi - 1}$$

- Price dispersion emerges
- Labor productivity and ultimately welfare fall
- *This effect arises both when inflation is inefficiently high or low*

The effects of ambiguity on inflation depend on how policy responds to inflation deviations

Characterizing the Steady State

Proposition

For $\beta \in [0, 1)$, $\epsilon \in (1, \infty)$, $\theta \in [0, 1)$, $\phi \in (1, \infty)$, $\psi \in [0, \infty)$, $\mathbb{V}(\mu, \cdot)$ is continuously differentiable around $\mu = 0$ and:

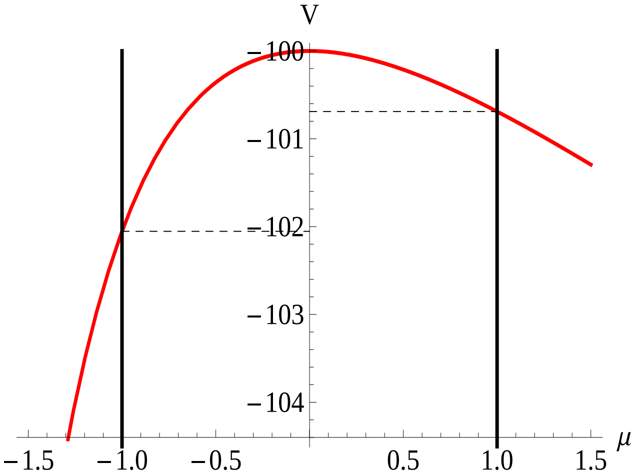
i. *attains a maximum at $\mu = 0$*
ii. *is strictly concave in μ*
iii. *under symmetry of the bounds ($\underline{\mu} = -\overline{\mu}$), for β sufficiently close to one, attains its minimum on $[-\overline{\mu}, \overline{\mu}]$ at $\mu = -\overline{\mu}$.*

Result

A reduction in ambiguity corresponds to a reduction in inflation (which approaches the target):

$$\Pi(\overline{\mu}') < \Pi(\overline{\mu}) \qquad \forall\ 0 \leq \overline{\mu}' < \overline{\mu}.$$

Steady-State Welfare as a Function of μ



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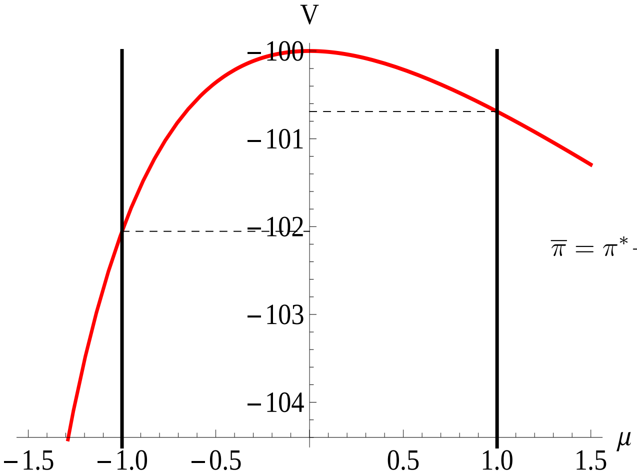


$$\overline{\pi} = \pi^* - \frac{\underline{\mu}}{\phi - 1} > \pi^*$$

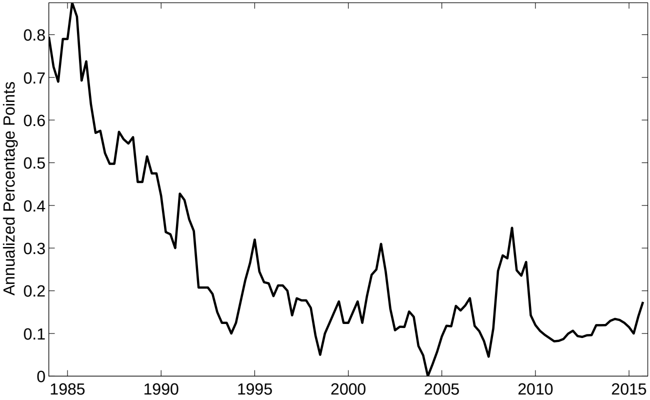
Model Implications

- If $\underline{\mu} \approx -\overline{\mu}$: $\overline{\pi} > \pi^*$
- if $|\underline{\mu}| << |\overline{\mu}|$: $\overline{\pi} < \pi^*$
- ϕ governs how $\overline{\pi} - \pi^*$ responds to changes in ambiguity

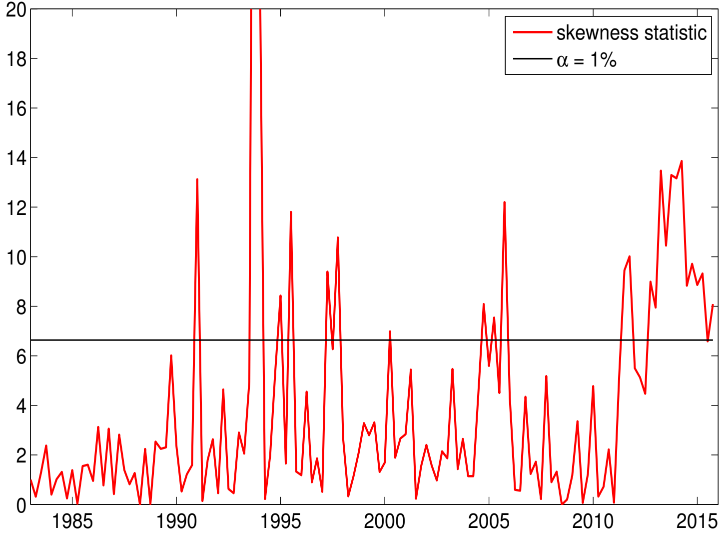
We bring these implications to the data

The Data

Blue Chip Fed Funds nowcast disagreement (interdecile dispersion)

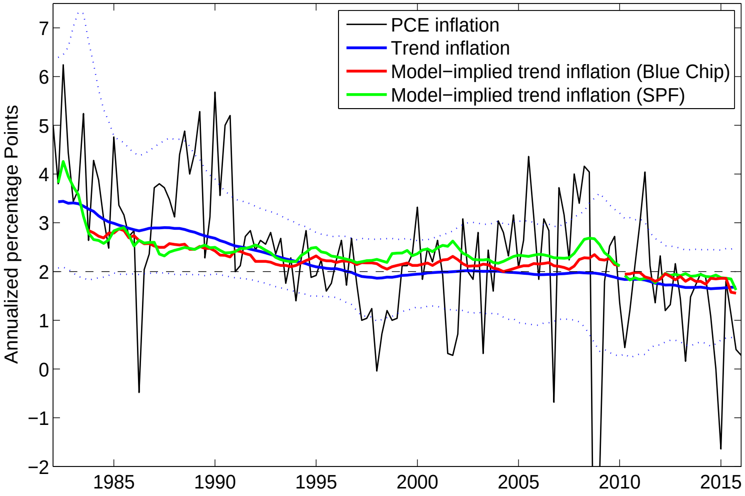


Putting Symmetry to the Test



Ambiguity and Trend Inflation

$$\color{red}{\overline{\pi}} = \pi^* - \frac{\mu}{\phi - 1} \qquad \pi^* = 2 \quad \phi = 1.5 \quad \mu = \{\underline{\mu}, \overline{\mu}\}$$



Optimal Monetary Policy: Overview

- Absent mismeasurement/misperception about the natural rate our monetary policy rule is optimal (implements first best)
- Is it still optimal when agents are not entirely sure about the policy rule?

We show that:

- If agents fear that policy will be too loose: it is optimal for the policymaker to implement a *somewhat* tighter policy (Volcker disinflation).
- If agents fear that policy will be too tight, it is optimal for the policymaker to implement a *somewhat* looser policy (post Great Recession).

Optimal Monetary Policy

Proposition

Given our setup

i. *with a small* $\overline{\mu} > 0$, $\underline{\mu} = -\overline{\mu}$ *and* $\underline{\phi} \leq \phi \leq \overline{\phi}$, *the following rule*

$$R_t = R_t^* \Pi_t^{\overline{\phi}} \quad (3)$$

where $R_t^* = R_t^n e^{\delta^*(\overline{\mu}, \overline{\phi}, \cdot)}$ *and* $0 < \delta^*(\overline{\mu}, \overline{\phi}; \cdot) < \overline{\mu}$, *is steady-state optimal in its class*

ii. $|\underline{\mu}| << |\overline{\mu}|$, *so that* $\mathbb{V}\left(\underline{\mu}, \cdot\right) > \mathbb{V}\left(\overline{\mu}, \cdot\right)$, *then*

$$R_t = R_t^* \Pi_t^{\overline{\phi}} \quad (4)$$

where $R_t^* = R_t^n e^{\delta^*(\underline{\mu}, \overline{\mu}, \overline{\phi}, \cdot)}$ *and* $-\overline{\mu} < \delta^*(\underline{\mu}, \overline{\mu}, \overline{\phi}; \cdot) < 0$.

▸ Dynamic Optimality

Conclusions

- Without resorting to exogenous shifts in the target or the parameter of the Taylor rule our model can explain trend inflation dynamics in the US before *and after* the crisis

- Policy implications:
  - In normal times, the less credible a policymaker is, the more hawkish it needs to be
  - Near the ZLB, however, when agents fear that policy might be too tight, it is optimal to implement looser policy than implied by the natural rate

Firm's problem

Firms:

- operate a linear production function: $Y_t = A_t N_t$
- receive a cost subsidy $\tau = 1/\epsilon$
- maximize expected profits subject to Calvo pricing frictions:

$$\max_{P_t^*} E_t \left[\sum_{s=0}^{\infty} \theta^s Q_{t+s} \left(\left(\frac{P_t^*}{P_{t+s}} \right)^{1-\epsilon} Y_{t+s} - \Psi \left(\left(\frac{P_t^*}{P_{t+s}} \right)^{-\epsilon} Y_{t+s} \right) \right) \right]$$

Which results in the first-order conditions:

$$\frac{P_t^*(i)}{P_t} = \frac{\mathbb{E}_t \sum_{j=0}^{\infty} \theta^j \left(\frac{P_{t+j}}{P_t} \right)^{\epsilon} \frac{\epsilon}{\epsilon-1} MC_{t+j}}{\mathbb{E}_t \sum_{j=0}^{\infty} \theta^j \left(\frac{P_{t+j}}{P_t} \right)^{\epsilon-1}}$$

$$\frac{P_t^*(i)}{P_t} = \left(\frac{1-\theta \Pi_t^{\epsilon-1}}{1-\theta} \right)^{\frac{1}{1-\epsilon}}$$

Back

Government

The government taxes to finance the subsidy. We lump the profits together with the tax, which results in the following:

$$T_t \quad = \quad P_t\left(-\tau\frac{W_t}{P_t}N_t + Y_t\left(1-(1-\tau)\frac{W_t\Delta_t}{P_tA_t}\right)\right) \tag{5}$$

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Dynamic Optimality

If leisure enters the felicity function linearly, the degree of ambiguity is sufficiently small and shocks to its level are i.i.d., it can be proven that equation (3) is:

i. dynamically optimal in its class

ii. can reduce the variability of the output gap and inflation around their worst-case steady-state as much as any other generic rule for a suitably high level of $\overline{\phi}$.

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Ambiguity in macro models

Mainly, two alternative preferences specifications used for representing ambiguity aversion in macro:

1. Multiple priors: Gilboa and Schmeidler, 1998 and Epstein and Schneider, 2003.
   - Multiple priors utility is not smooth when belief sets differ in means.
   - $\rightarrow$ Effects of ambiguity show up in a first order approximation
     Ilut and Schneider (2014)
2. Multiplier preferences: Hansen and Sargent, 2001.
   - Fear of misspecification: statistical perturbation around an approximating model.
   - Smooth utility function

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Private Sector Confidence and Transparency

- There is consensus that transparency increased from the late 1979s onwards, e.g. Lindsey (2003), Bernanke (2013)

- There is evidence that transparency translates into reduction in private sector's uncertainty
  - Swanson (2006): since the late 1980s private sector forecasters have been better at forecasting the Fed Funds rate, their cross-section dispersion shrank. Provides evidence that it is linked to transparency.
  - Ehrmann et al. (2012) also find that increased transparency lowers disagreement.
  - Boyarchenko et al. (2016) show how Fed announcements affect market confidence lowering the risk premium.

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Calibration

β	Subjective Discount	.995
ψ	Inverse Frish Elasticity	1
ϕ	Inflation Responsiveness	1.5
ϵ	Demand elasticity	15
θ	Calvo probability	.83

A simple equivalence: Illustration

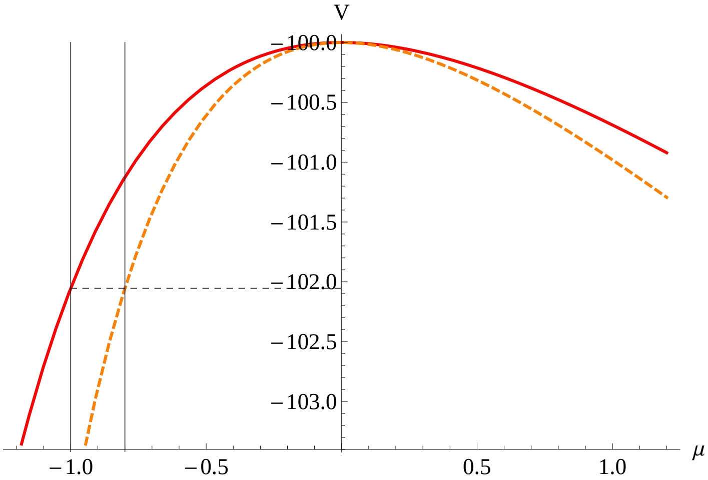

Figure: Welfare function for $\phi = 1.5$ (solid red line) and $\phi = 1.4$ (orange dashed line).