The Central Bank's Dilemma:

Look through supply shocks or control inflation expectations?

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Introduction

- Inflation spurt since 2021 elicited similar policy responses
- Initially most central banks didn't respond
  - rationale: *inflation due to temporary supply shocks*
- Sudden pivot after months of continuing bad inflation data
  - rationale: *need to keep inflation expectations anchored*
  - fear of wage-price spiral

Issues

- *Should* central banks look through supply shocks?
- Does risk of de-anchoring of inflation expectation limit this looking-through?
- Can one rationalize observed central bank behavior?
  - Look-through supply-drive inflation shocks initially
  - Sudden monetary tightening

Two Modifications

- Relax rational expectations
- Introduce bounded rationality: *level-k thinking*
  - nests rational expectations and adaptive expectations
  - inflation expectations also respond to current inflation
- Assume wages stickier than prices
  - generates potential *wage-price spiral*

Results 1

- Under rational expectations, optimal policy looks-through supply-driven inflation shocks
- Under adaptive expectations, optimal policy always responds proportionally to supply-driven inflation
- Neither case generates sudden policy pivot

Results 2

- Optimal response to supply shocks under *level-k thinking*
  - initially look-through but pivot sharply if inflation deviations cross threshold
- Arises when
  - the central bank cares “enough” about employment

Model

- Builds on Blanchard-Kiyotaki (1987)
- Closed economy with households, firms and a central bank
- Households supply differentiated labor: wage-setting power
- Firms supply differentiated goods: price-setting power

Model II

- All firms receive same productivity draw : $\theta_{jt} = \theta_t$ for all j
- **Assumption:** $\ln \theta_t = \ln \theta_{t-1} + \epsilon_t$ where $\epsilon_t \sim iid \ \left(0, \sigma_\theta^2\right)$
- Interpret productivity shock as aggregate oil price shock
- Wages set before observing shocks for the period
- Wages and prices are both set for one-period

Phillips Curve in Model

$$\pi_t - \pi^* = \mathbb{E}^{WS}_{t-1}(\pi_t - \pi^*) + \mathbb{E}^{WS}_{t-1}\left(\ln N_t - \ln \bar{N}\right) - (\ln \theta_t - \mathbb{E}^{WS}_{t-1} \ln \theta_t)$$

- Phillips curve in deviations

$$\hat{\pi}_t = \mathbb{E}^{WS}_{t-1}(\hat{\pi}_t) + \mathbb{E}^{WS}_{t-1}\left(\hat{N}_t\right) - \mathbb{E}^{WS}_{t-1}\hat{\theta}_t$$

- Key features of this Phillips curve
  - inflation at date t is driven by expectations at date $t-1$
  - productivity shocks have direct effect on inflation
  - no divine coincidence: stabilizing inflation expectations does not stabilize output

Monetary Policy Rule

- Monetary policy ϕ is set to have employment obey

$$N_t = \bar{N} \left(\frac{1 + \pi_t}{1 + \pi^*} \right)^{-\phi_t}$$

- Formulation directly recognizes an employment tradeoff in reducing inflation
- Use Euler equation to derive path of ι that implements rule
- Formulation more convenient for highlighting link between expectation formation and policy

Euler

Equilibrium System

- Inflation and employment

$$\hat{\pi}_t = \mathbb{E}^{WS}_{t-1}\hat{\pi}_t + \mathbb{E}^{WS}_{t-1}\hat{N}_t - \hat{\theta}_t$$
$$\hat{N}_t = -\phi_t[\mathbb{E}^{WS}_{t-1}\hat{\pi}_t + \mathbb{E}^{WS}_{t-1}\hat{N}_t - \hat{\theta}_t]$$

- Notation

$$\begin{aligned}\hat{\pi}_t &= \pi_t - \pi^* \\ \hat{N}_t &= \ln N_t - \ln \bar{N} \\ \hat{\theta}_t &= \ln \theta_t - \mathbb{E}^{WS}_{t-1} \ln \theta_t\end{aligned}$$

Level-k thinking

- Start with initial seed (level-0) about aggregate expectation
- Compute aggregate outcome under initial seed
- Update aggregate expectation and recompute aggregates
- Repeat k-times for level-k thinking
- Finite k iterations reflects bounded rationality

Level-k thinking II

- Let initial seed (level-0) expectation be

$$\mathbb{E}_{t-1}\hat{\pi}_t^0 = \hat{\pi}_{t-1}$$
$$\mathbb{E}_{t-1}\hat{N}_t^0 = \hat{N}_{t-1}$$

- Equilibrium system

$$\hat{\pi}_t^{LKT} = (1-\phi_t)^k \left[\hat{\pi}_{t-1} + \hat{N}_{t-1}\right] - \hat{\theta}_t$$
$$\hat{N}_t^{LKT} = -\phi_t \left[(1-\phi_t)^k \left\{\hat{\pi}_{t-1} + \hat{N}_{t-1}\right\} - \hat{\theta}_t\right]$$

Policy Problem

- Policymaker's problem

$$\min_{\phi_t} \sum_{t=0}^{\infty} \beta_{CB}^{t} \mathbb{E}_{t-1}^{RE} \left(\hat{\pi}_t{}^2 + \mu \hat{N}_t^2 \right)$$

- Define $x_t \equiv \hat{\pi}_t + \hat{N}_t$

- Restated problem:

$$\min_{\phi_t} \sum_{t=0}^{\infty} \beta_{CB}^{t} \mathbb{E}^{RE} \left[(1 + \mu \phi_t^2) \left((1 - \phi_t)^{2k} x_{t-1}^2 + \sigma_\theta^2 \right) \right]$$

Rational and Adaptive Expectations

- Rational expectations: $k \to \infty$

$$\phi_t^{RE} = 0$$

- Look through any deviations of inflation from target

- Adaptive expectations: $k = 0$

$$\phi_t^{AE} = \frac{\beta_G a_1}{\mu + \beta_G a_1} \in (0, 1)$$

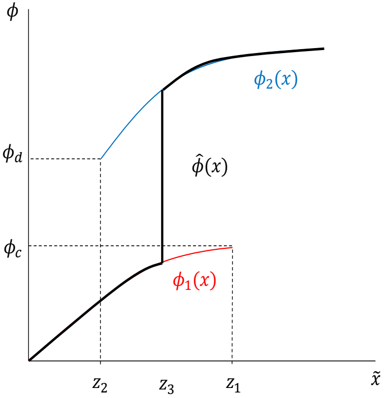
- No policy pivot: ϕ^{AE} is constant

Level-k thinking: analytical results

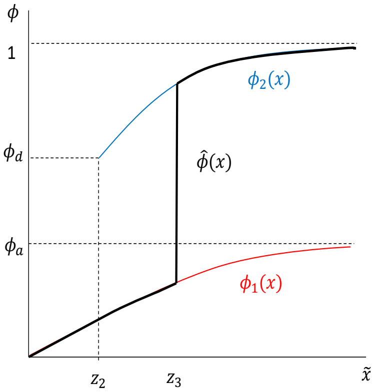
- Special case $\beta_{CB} = 0, k = 1$
- Define $\tilde{x}_{t-1} \equiv \frac{x_{t-1}^2}{\sigma_\theta^2}$
- Optimal ϕ_t depends on $\tilde{x}_{t-1}$
- For $\mu > 4$ there exist two functions: $\phi_1(\tilde{x}),\ \phi_2(\tilde{x})$
  - functions represent local optima
  - functions have overlapping domains
- Need to determine global optima in the overlapping zone

Proposition: Policy Pivot

If μ is sufficiently big, there exists a unique cutoff for $\tilde{x}_{t-1}$, such that at this cutoff, the global optimum $\hat{\phi}\left(\tilde{x}_{t-1}\right)$, jumps up discontinuously.



$4 < \mu < 8$

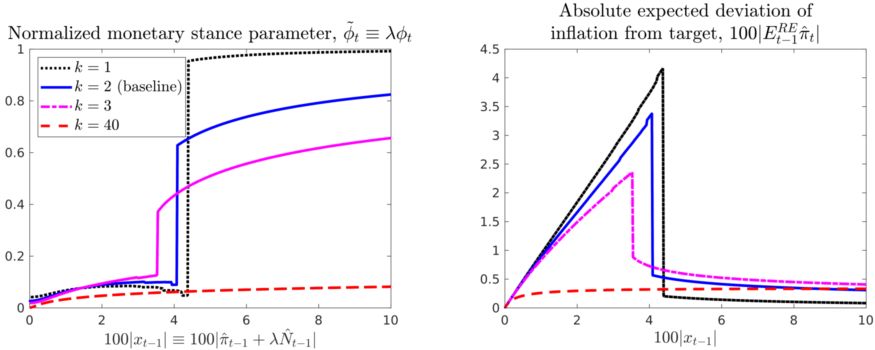


$\mu > 8$

Intuition for Pivot: Non-convexity

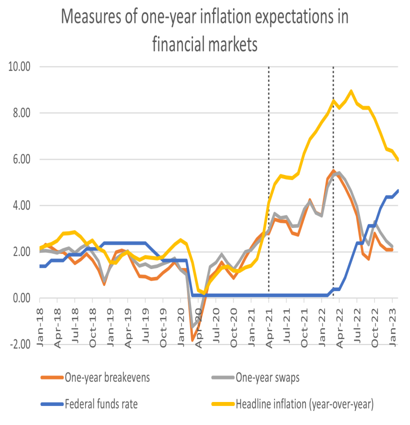
- Policy tightening reduces employment *directly*
- Tightening reduces inflation expectations: raises employment *indirectly*
  - wages fall immediately in response
- Indirect effect rises with ϕ and is greater the larger is $\hat{\pi}$
- Direct effect overwhelmed by indirect effect at high enough $\hat{\pi}$
- Soft landing for output despite policy pivot

Dynamic model with $\beta_G = 0.995$: Effect of k

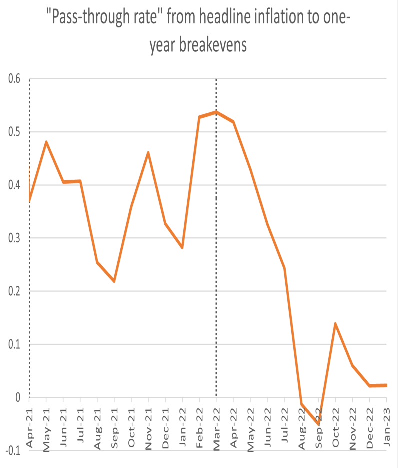


- Higher k shifts pivot point lower and reduces size of pivot
- Pivot disappears for sufficiently high k

Key Mechanism: Inflation Expectations and Policy



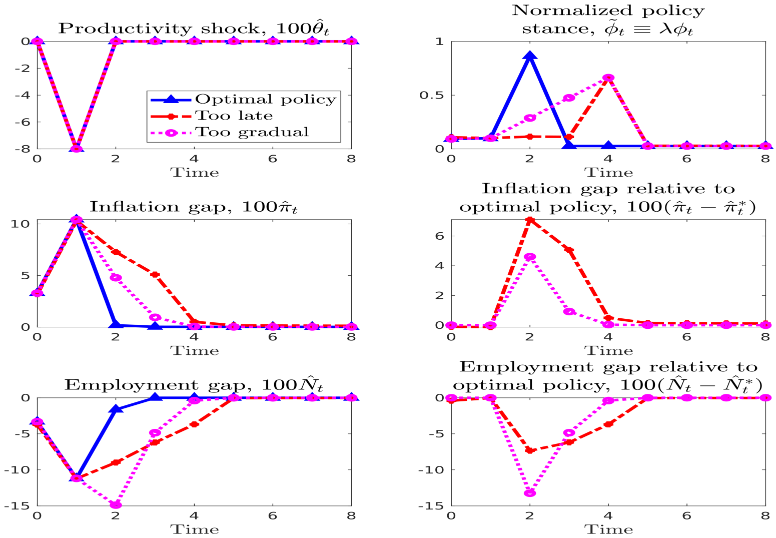
Note: Dashed vertical lines mark (i) the first post-COVID instance of headline inflation exceeding 3 percent; and (ii) the first post-COVID Fed hike.



Policy Errors

- Sharp pivot often hard to implement
- Fear of economic disruptions induce demand for gradualism
- How expensive are gradual paths relative to sharp pivots?

Two deviations from optimal policy



Conclusions

- Framework for studying monetary response to supply shocks
- Key ingredients
  - bounded rationality: level-k thinking
  - prices more flexible than wages
- Tradeoff between stabilizing output and de-anchoring inflation expectations
- Looking through supply shocks can be optimal, till some point
- Late or gradual tightening can be expensive

Slope of Phillips Curve

- Phillips curve in the model is

$$\hat{\pi}_t = \mathbb{E}_{t-1}\hat{\pi}_t + \mathbb{E}_{t-1}\hat{N}_t - \hat{\theta}_t$$

- Slope is unity: restrictive and empirically debatable

- Generalization with GHH preferences

$$\mathbb{E}\sum_{t=0}^{\infty}\beta^t \ln\left(C_{it} - \eta\theta_t N_{it}^{1+\lambda}\right),$$

- Revised Phillips curve

$$\hat{\pi}_t = \mathbb{E}_{t-1}\hat{\pi}_t + \lambda\mathbb{E}_{t-1}\hat{N}_t - \hat{\theta}_t,$$

Revised interpretation of μ

- Define $\tilde{\mu} \equiv \frac{\mu}{\lambda^2}$ and $\tilde{\phi}_t \equiv \lambda \phi_t$
- Policy problem can be written as

$$\min_{\tilde{\phi}_t} \sum_{t=0}^{\infty} \beta_G^t \mathbb{E} \left[(1 + \tilde{\mu} \tilde{\phi}_t{}^2) \left((1 - \tilde{\phi}_t)^{2k} x_{t-1}^2 + \sigma_\theta^2 \right) \right]$$

  subject to

$$x_t = (1 - \tilde{\phi}_t)^{k+1} x_{t-1} - (1 - \tilde{\phi}_t) \hat{\theta}_t$$

- Same problem but with $\tilde{\phi}$ and $\tilde{\mu}$ replacing ϕ and μ
- Propositions with μ go through with $\tilde{\mu}$

Euler equation

- The Euler equation is

$$\iota_{t+1} - \bar{\iota} = \mathbb{E}_t(\ln N_{t+1} - \ln N_t) + \mathbb{E}_t(\pi_{t+1} - \pi^*)$$

- Solving forward, this gives

$$\ln N_t - \ln \bar{N} = -\sum_{h=1}^{\infty} \mathbb{E}_t \cdot \cdot \mathbb{E}_{t+h-1}[\iota_{t+h} - \bar{\iota} - (\pi_{t+h} - \pi^*)]$$

Rule