Monetary Policy without an Anchor

Luigi Bocola
Stanford University, CEPR and NBER

Alessandro Dovis
University of Pennsylvania and NBER

Kasper Jorgensen
ECB

Rishabh Kirpalani
University of Wisconsin-Madison

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- The **risk of de-anchoring** of inflation expectations key consideration for policymakers during inflationary episodes

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- This paper: **Model** + **Data** to
  - Formalize trade-off faced by central bank when inflation expectations can de-anchor
  - Quantify risk of de-anchoring and benefits of maintaining inflation expectations anchored

Theory and measurement

- New Keynesian model with optimal monetary policy
  - Private sector **uncertain** about the policymaker's type, learns from actions
  - Policy surprises → update beliefs on policymaker's type → inflation expectations
  - **Reputation channel**: when facing inflationary shocks, more incentives to tighten

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- Quantitative strategy: Estimate elasticity, combine it with model for counterfactual
  - Find large elasticities for Brazil compared to other countries
  - When fit to Brazil, reputation channel key driver of monetary policy ($\approx$ 9-fold increase in the slope of the Phillips curve)

Outline

▸ Related Literature

Environment

- Baseline New Keynesian model. Private sector behavior summarized by

$$\pi_t(1+\pi_t) = y_t \frac{\left[\mu_t \chi y_t^{\nu} c_t - 1\right]}{\phi[\mu_t - 1]} + \beta \mathbb{E}_t \left[\left(\frac{c_{t+1}}{c_t}\right)^{-1} \pi_{t+1}(1+\pi_{t+1}) \right]$$

$$\frac{1}{1+i_t} = \beta \mathbb{E}_t \left[\left(\frac{c_{t+1}}{c_t}\right)^{-1} \frac{1}{(1+\pi_{t+1})} \right]$$

$$y_t = c_t + \frac{\phi}{2}\pi_t^2$$

where $y_t = Y_t/z_t$, $c_t = C_t/z_t$, $\pi_t = P_t/P_{t-1}$ and z_t a technology shock

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  where $y_t = Y_t / z_t$, $c_t = C_t / z_t$, $\pi_t = P_t / P_{t-1}$ and z_t a technology shock

- i_t chosen by Central Bank (CB) without commitment. Objective function at t:

$$R_t = -\alpha\left(\theta_t, \varepsilon_t\right) \pi_t^2 - \left[1 - \alpha\left(\theta_t, \varepsilon_t\right)\right] \left(\frac{y_t - y^\star}{y^\star} \right)^2$$

  - $\theta_t \in \left\{ \theta^H, \theta^D \right\}$ is the CB "type". Markov process with transition matrix P_θ
  - ε_t is an iid Gaussian "monetary shock"

Information sets, timing and expectations

Private sector doesn't observe $(\theta_t, \varepsilon_t)$, learns CB type from actions

- Private sector prior about CB being a Hawk: ρ
  - We refer to ρ as the CB **reputation**
- At the beginning of each period the shocks $s = (\mu, z)$ and (θ, ε) are realized
- The monetary authority chooses the level of the nominal interest rate, $\bar{i}$
- Private sector updates its prior ρ using Bayes rule

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- Focus on Markov perfect equilibrium: public state (s, ρ), central bank's state $(s, \rho, \theta, \epsilon)$

▸ Primal Problem

Outline

Simplified economy

- No inflation-bias, $y^\star = y^{\text{fp}} \equiv (\mu\chi)^{-\frac{1}{\nu+\sigma}}$
  - $\pi_D^{ss} = \pi_H^{ss} = 0$
  - Log-linearize equilibrium conditions around zero-inflation steady state

$$\pi_t = \kappa \hat{y}_t + \beta \mathbb{E}_t \left[\pi_{t+1}\right] + \hat{\mu}_t$$

$$R(\hat{y}_t, \pi_t; \alpha_t) = -\frac{1}{2}\left[\alpha_t \pi_t^2 + (1-\alpha_t)\hat{y}_t^2\right]$$

where $\hat{y}_t = \log y_t - \log y^*$

- Permanent types. Unknown at $t = 1$, revealed at $t = 2$
  - No monetary shock from $t \geq 2$

Perfect information benchmark

From $t \geq 2$ the problem of the Central Bank problem reduces to static problem

$$\max_{\pi,\hat{y}} R(\pi, \hat{y}; \alpha(\theta)) \qquad \text{s.t.} \qquad \pi = \kappa\hat{y} + \beta\mathbb{E}[\pi_2(\theta, \hat{\mu}')|\hat{\mu}] + \hat{\mu}$$

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Optimality condition:

$$\underbrace{\alpha(\theta)\pi\kappa}_{R_\pi \frac{\partial \pi}{\partial \hat{y}}} = \underbrace{-[1-\alpha(\theta)]\hat{y}}_{-R_y}$$

Substituting in the Phillips curve, we obtain

$$\pi_2(\theta, \hat{\mu}) = \frac{[1-\alpha(\theta)]}{[1-\alpha(\theta)](1-\beta\rho_\mu) + \alpha(\theta)\kappa^2}\hat{\mu}$$

$$\hat{y}_2(\theta, \hat{\mu}) = \frac{-\alpha(\theta)\kappa}{[1-\alpha(\theta)](1-\beta\rho_\mu) + \alpha(\theta)\kappa^2}\hat{\mu}$$

- The higher $\alpha(\theta)$, the smaller the sensitivity of inflation to μ

Monetary policy with imperfect information

In period 1, the decision problem is

$$\max_{\pi,\hat{y}} R(\pi,\hat{y};\alpha(\theta,\varepsilon)) + \beta\mathbb{E}[V(\hat{\mu}',\theta)|\hat{\mu}] \qquad \text{s.t.} \qquad \pi = \kappa\hat{y} + \beta\,\Pi_2(\hat{y};\hat{\mu},\rho_0) + \hat{\mu},$$

where

$$\Pi_2(\hat{y};\hat{\mu},\rho_0) = \rho_1(\hat{y};\hat{\mu},\rho_0)\mathbb{E}[\pi_2(\theta^H,\hat{\mu}')|\hat{\mu}] + [1-\rho_1(\hat{y};\hat{\mu},\rho_0)]\mathbb{E}[\pi_2(\theta^D,\hat{\mu}')|\hat{\mu}]$$

Key difference with perfect info: CB actions affect inflation expectations via **reputation**

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Key difference with perfect info: CB actions affect inflation expectations via **reputation**

The optimality condition becomes

$$\alpha(\theta,\varepsilon_1)\pi_1\left[\kappa + \beta\,\Pi_2'(\hat{y};\hat{\mu},\rho_0)\right] = -[1-\alpha(\theta,\varepsilon_1)]\hat{y}_1$$

Zooming on $\Pi_2'(\hat{y}; \hat{\mu}, \rho_0)$

$$\Pi_2'(\hat{y}; \hat{\mu}, \rho_0) = \frac{\partial \rho_1(\hat{y}; \hat{\mu}, \rho_0)}{\partial \hat{y}} \mathbb{E}\left[\pi_2\left(\theta^H, \hat{\mu}'\right) - \pi_2\left(\theta^D, \hat{\mu}'\right) | \hat{\mu}\right]$$

Elasticity is **non-negative**. Suppose $\hat{\mu} > 0$. Then

- Private sector updates toward the Dove when it sees higher output, $\frac{\partial \rho_1(\hat{y}; \hat{\mu}, \rho_0)}{\partial \hat{y}} < 0$
- Because $\mathbb{E}[\pi_2(\theta^H, \hat{\mu}') - \pi_2(\theta^D, \hat{\mu}')|\hat{\mu}] < 0$, we have $\Pi_2'(\hat{y}_1; \mu, \rho_0) > 0$

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Elasticity is **state-dependent**

- Equals zero when $\rho_0 = \{0, 1\} \Rightarrow$ Elasticity larger when private sector uncertain
- Equals zero when $\hat{\mu} = 0 \Rightarrow$ Elasticity larger when economy hit by a supply shock

The reputation channel

Proposition

The central bank is more "Hawkish" when its type is unknown. That is, if $\hat{\mu} > 0$, then $\hat{y}_1$ is lower than in the Markov equilibrium under perfect information, strictly so if $\rho_0 \in (0, 1)$.

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- With perfect info, reducing output when $\hat{\mu} > 0$ has the benefit of reducing inflation
  - By the slope of the Phillips curve κ

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- With perfect info, reducing output when $\hat{\mu} > 0$ has the benefit of reducing inflation
  - By the slope of the Phillips curve κ
- With **imperfect information**, there is an **additional benefit**
  - By lowering output, CB improves reputation. Higher reputation reduces inflation
  - "As if" Phillips curve is steeper

Taking stock

- Incentives to acquire reputation and effects on aggregates depend on $\Pi_2'(\hat{y}_1; \mu, \rho_0)$

  ▸ Details

- In the infinite horizon economy, same trade-off as in the simplified economy

$$-\left\{R_{\pi,t}\kappa + R_{y,t}\right\}\frac{\partial y_t}{\partial i_t} = \sum_{k=1}^{\infty}\beta^k \mathbb{E}_t^{cb}\left\{R_{\pi,t+k-1}\frac{\partial \mathbb{E}_t^{\rho_{t+k}}\left[\pi_{t+k}\right]}{\partial \rho_{t+1}}\right\}\frac{\partial \rho_{t+1}}{\partial i_t}$$

  Equation relates (unobservable) "reputation wedge" to (potentially observable) sensitivity of inflation expectations to policy changes

- Measure $\frac{\partial \mathbb{E}_t[\pi_{t+j+1}]}{\partial \rho_{t+1}}\frac{\partial \rho_{t+1}}{\partial i_t}$ in data to discipline reputation mechanism's size in model

Outline

Data and baseline specification

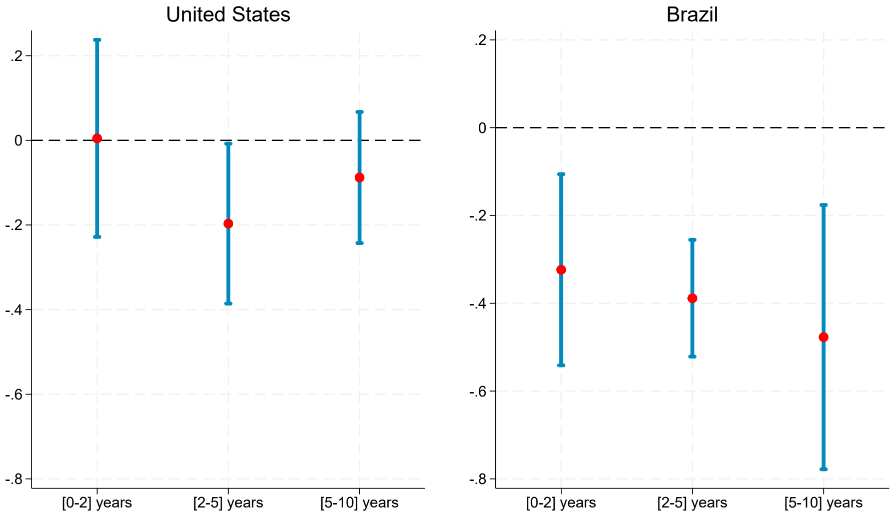
- Baseline specification

$$\Delta \mathbb{E}_t[\bar{\pi}_{k,k+s}] = a_{(k,s)} + b_{(k,s)} \Delta \mathbb{E}_t[i_t] + e_{(k,s),t}$$

  $b_{(k,s)}$ measures sensitivity of inflation expectations between k and $k+s$ years from t

- Countries: Brazil, Chile, Mexico, Euro area, US, UK. Sample: 2010-2024
- Two measures of long-run inflation expectations
  - Five year/five year break-even inflation (daily frequency)
  - Professional forecasters surveys (monthly/quarterly)
- Monetary policy surprises computed using short-term rates
  - 3mo OIS for emerging market economies
  - 1yr OIS for Euro area, US and UK

Brazil vs US



Results

Panel A: Market-based results

	Brazil	Chile	Mexico	Euro area	UK	US
$b_{(5y5y)}$	$-0.48^{\star\star\star}$	-0.05	0.02	0.03	-0.05	-0.09
	(0.18)	(0.05)	(0.07)	(0.06)	(0.07)	(0.09)
R^2	0.08	0.03	0.00	0.00	0.01	0.00
Sample	2010-2024	2010-2023	2010-2024	2010-2024	2010-2024	2010-2024
# obs.	92	104	109	134	143	114

Panel B: Survey-based results

	Brazil	Chile	Mexico	Euro area	UK	US
b	$-0.18^{\star\star}$	-0.00	0.03	0.11	0.29	-0.04
	(0.09)	(0.02)	(0.06)	(0.08)	(0.23)	(0.06)
R^2	0.22	0.00	0.00	0.05	0.02	0.00
Sample	2010-2024	2010-2024	2010-2024	2010-2024	2010-2024	2010-2024
# obs.	92	117	106	57	47	54

- Large elasticities for Brazil
- Not significantly different from zero for other countries

Outline

Quantitative analysis

- Focus on Brazil
  - Among the first countries to raise interest rates after the pandemic, with CB explicitely citing risk of a de-anchoring of inflation expectations
  - Strong sensitivity of long-run inflation expectations to monetary surprises
- Calibration strategy:
  - Match key moments of inflation, nominal interest rates and de-trended output
  - Match elasticity of inflation expectations to monetary surprises ▸ Elasticity in model
- Questions:
  - How important are reputation building motives?
  - What are the macroeconomic effects of reputation gains?

Quantifying the reputation channel

To assess strenght of reputation, compare benchmark to economy with "myopic" CB

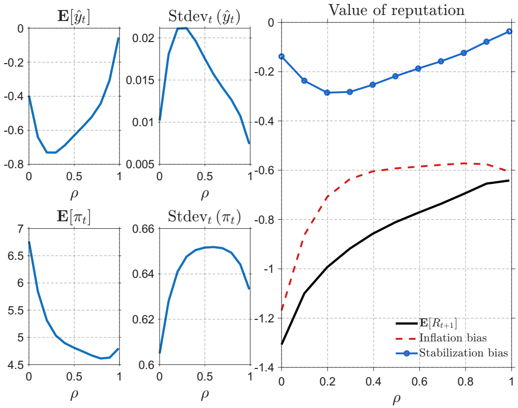
	Benchmark	Myopic	Benchmark	Myopic
Moment	High uncertainty		Low uncertainty	
Mean(π_t)	4.42	5.61	5.12	5.30
Stdev(π_t)	1.54	1.83	1.83	1.95
Mean($\hat{y}_t$)	-0.84	-0.41	-0.54	-0.30
Stdev($\hat{y}_t$)	0.68	0.13	0.70	0.13
Mean$\left(\frac{R_t^{bench} - R_t}{\text{abs}\left(R_t^{bench}\right)}\right)$	0.00	-0.37	0.00	-0.13

- Reputation moderates inflationary pressures (at the cost of higher output volatility)
- Ignoring reputation leads to substantial losses for the CB
- Effects stronger in periods of high policy uncertainty

The value of reputation

$$\mathbb{E}_t^{cb}[R_{t+1}|\theta, s, \rho] \approx -\mathbb{E}_t\left\{[1-\alpha_{t+1}(\theta)]\,\mathbb{E}_t\left[\frac{y_{t+1}-y^\star}{y^\star}|\varepsilon_{t+1}\right]^2 + \alpha_{t+1}(\theta)\mathbb{E}_t\left[\pi_{t+1}|\varepsilon_{t+1}\right]^2\right\}$$

$$-\mathbb{E}_t\left[[1-\alpha_{t+1}(\theta)]\,Var_t\left(\frac{y_{t+1}-y^\star}{y^\star}|\varepsilon_{t+1}\right) + \alpha_{t+1}(\theta)Var_t\left[\pi_{t+1}|\varepsilon_{t+1}\right]\right].$$



Two observations

1 Model can rationalize different monetary policy responses to the post-pandemic inflation episode

- Nakamura, Riblier and Steinsson (2025): high-credibility countries tigthened less aggressively and yet observed similar inflation dynamics
- Consistent with the "reputation dividend" that we document IRFs

2 Long-run inflation expectations not a good indicator of "de-anchoring" *risk*

- Inflation expectations flat for $\rho_t \geq 0.2$
- But inflation expectations very sensitive to policy choices for $\rho_t \in (0.2, 0.7)$

Conclusions

- Studied the trade-offs central banks face in keeping inflation expectations "anchored"
  - Short run output distortions vs. lower and more stable inflation expectations
- Sufficient statistic to gauge strength of reputation mechanism: pdv of elasticity of inflation expectations to interest rate surprises
  - Estimated by applying high-frequency methods to bond market data
  - Elasticity sizable for some emerging market economies
- Applied framework to Brazil
  - Reputation building motives key driver of monetary policy
  - Gains in reputation improved substantially the inflation/output trade-off

Literature

- Reputation and monetary policy: Barro and Gordon (1983), Backus and Driffil (1985), Rogoff (1985), Amador and Phelan (2024), Lu, King and Pasten (2016), Gati (2024), King and Lu (2022), Carvello, Carrasco and Martinez-Buera (2025)
  - Strategy to quantify the strength of reputation channel
- Measures of de-anchoring: Coibion, Gorodnichenko (2025), Bernanke (2007), Carvalho, Eusepi, Moench and Preston (2023)
  - "Elasticity" of inflation expectations more informative about risk than their "level"
- Monetary shocks and inflation expectations: Gurkaynak, Sack and Swanson (2005), Nakamura and Steinsson (2018), De Pooter et al. (2014), Bonomo et al. (2024)
- Monetary policy and inflation spikes post Covid: Gagliardone and Gertler (2023), Comin, Johnson and Jones (2023), Bocola, Dovis, Jorgensen and Kirpalani (2024), Nakamura, Riblier and Steinsson (2025), ...
  - Combine high-frequency bond market data with structural model to assess role of monetary policy in emerging markets during this episode

Return

Equilibrium

- Can characterize equilibrium outcome by solving

$$V(s,\rho,\theta,\varepsilon) = \max_{y,\pi,c} R(\pi,y;\alpha(\theta,\varepsilon)) + \beta\mathbb{E}\left[V(s',\rho',\theta',\varepsilon')\Big| s,\theta\right]$$

$$\begin{aligned}
\pi(1+\pi) &= y\frac{[\mu_t \chi y^{\nu} c - 1]}{\phi[\mu-1]} + \beta\mathbb{E}\left[\left(\frac{c'}{c}\right)^{-1}\pi'\left(1+\pi'\right)\Big| s,\rho'\right] \\
y &= c + \frac{\phi}{2}\pi^2 \\
\rho' &= \rho'\left(\theta^H | s,\rho,y\right)
\end{aligned}$$

- The law of motion for reputation satisfies Bayes' rule

$$\rho'\left(\theta^H|s,\rho,y\right) = \frac{\rho\Phi\left(\varepsilon : y(s,\rho,\theta^H,\varepsilon) = y\right)P_{HH} + (1-\rho)\Phi\left(\varepsilon : y(s,\rho,\theta^D,\varepsilon)=y\right)P_{DH}}{\rho\Phi\left(\varepsilon : y(s,\rho,\theta^H,\varepsilon)=y\right) + (1-\rho)\Phi\left(\varepsilon : y(s,\rho,\theta^D,\varepsilon)=y\right)}$$

Return

Measuring the reputation channel

In the simplified model:

Proposition

Let $\Delta\mathbb{E}[i_1(\hat{y}_1;\mu,\rho_0)]$ *be a "monetary surprise"*

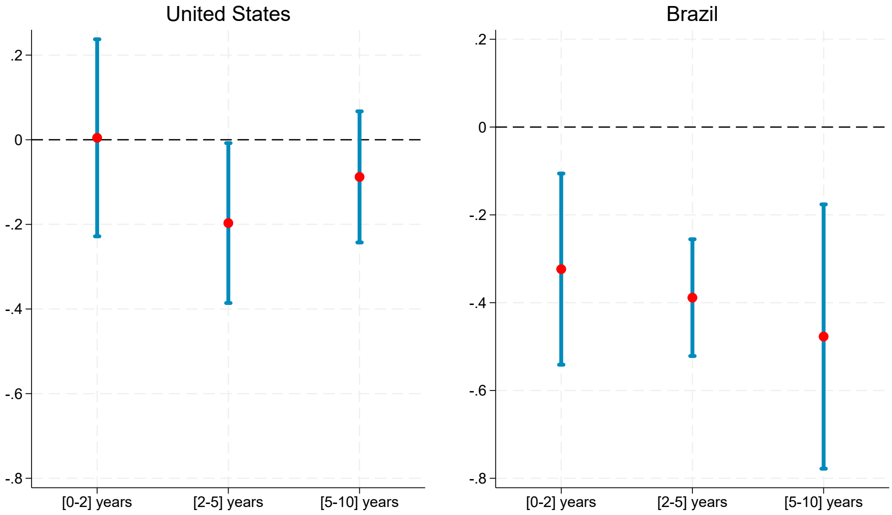
$$\Delta\mathbb{E}\left[i_1\left(\hat{y}_1;\mu,\rho_0\right)\right]=i_1\left(\hat{y}_1;\mu,\rho_0\right)-\mathbb{E}\left[i_1\left(\hat{y}_1(\mu,\rho_0,\theta,\varepsilon);\mu,\rho_0\right)\middle|\mu,\rho_0\right],$$

and $\Delta\mathbb{E}\left[\pi_2\left(\hat{y}_1;\mu,\rho_0\right)\right]$ *be the revision in expected inflation in period 2 after the realization of monetary policy. Then, we have*

$$\frac{\Delta\mathbb{E}\left[\pi_2\left(\hat{y}_1;\mu,\rho_0\right)\right]}{\Delta\mathbb{E}[i_1\left(\hat{y}_1;\mu,\rho_0\right)]}\approx-\frac{\Pi_2'\left(\bar{y};\mu,\rho\right)}{\sigma-\left(1+\sigma\frac{1-\beta}{\kappa}\right)\Pi_2'\left(\bar{y};\mu,\rho\right)}$$

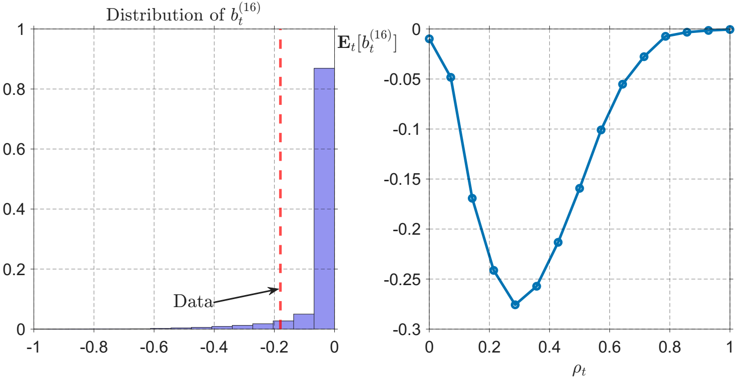
▸ Return

Brazil vs US



Return

Elasticity: model vs data



Two key ingredients to produce sizable long-run elasticity:

- Slow learning: $P_\theta = 0.995$ and $\sigma_\varepsilon = 2.4$
- Inflation bias: $\delta = 1.016$

Return

Model fit

Moment	Data	Model
Stdev($\log Y_t$)	1.95	2.02
Stdev(π_t)	2.01	1.82
Stdev(i_t)	2.78	3.27
Acorr($\log Y_t$)	0.90	0.84
Acorr(π_t)	0.92	0.91
Acorr(i_t)	0.95	0.45
Corr($\log Y_t, \pi_t$)	-0.23	0.00
Corr($\log Y_t, i_t$)	-0.45	-0.39
Corr(π_t, i_t)	0.81	0.54
Mean(π_t|Dove)	6.68	6.45
Mean(i_t|Dove)	10.83	10.73
Mean(π_t|Hawk)	4.23	4.60
Mean(i_t|Hawk)	8.42	7.06
$b^{(16)}$	-0.18	-0.15

- Model fits reasonably well output, inflation and nominal interest rates in the sample
- Produces a sizable elasticity of long-run inflation expectations to monetary surprises

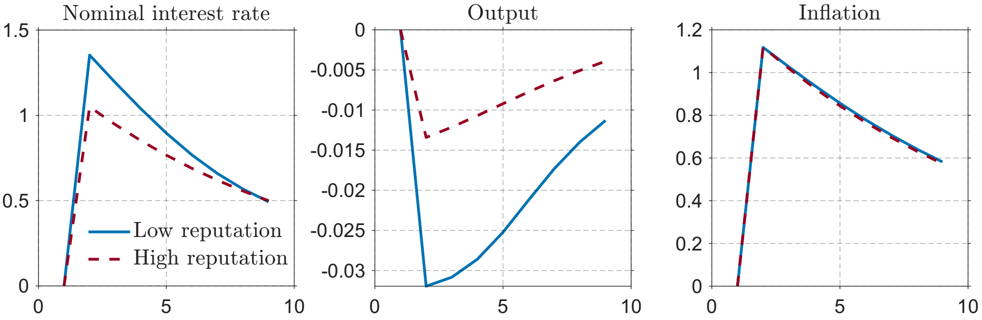
Return

Calibration

Parameter	Value	Note
ϕ	133.333	Adjustment cost, inflation
$1/\sigma$	1.000	Intertemporal elasticity of substitution
ν	1.000	Frisch elasticity of labor supply
β	0.990	Discount rate
$\bar{\mu}$	1.200	Average markup
χ	0.833	Disutility of labor
ρ_z	0.950	Persistence, productivity shocks
σ_z	0.065	Standard deviation, productivity shocks
ρ_μ	0.900	Persistence, markup shocks
σ_μ	0.013	Standard deviation, markup shocks
δ	1.016	Output target
θ_H	0.500	Weight on inflation, Hawk
θ_D	0.150	Weight on inflation, Dove
P_θ	0.995	Probability of remaining in a policy regime
σ_ε	2.400	Standard deviation, monetary shocks

Return

IRFs to markup shocks: high vs low reputation



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