Louder Than Rates:

The Systematic Nature of Central Bank Communication

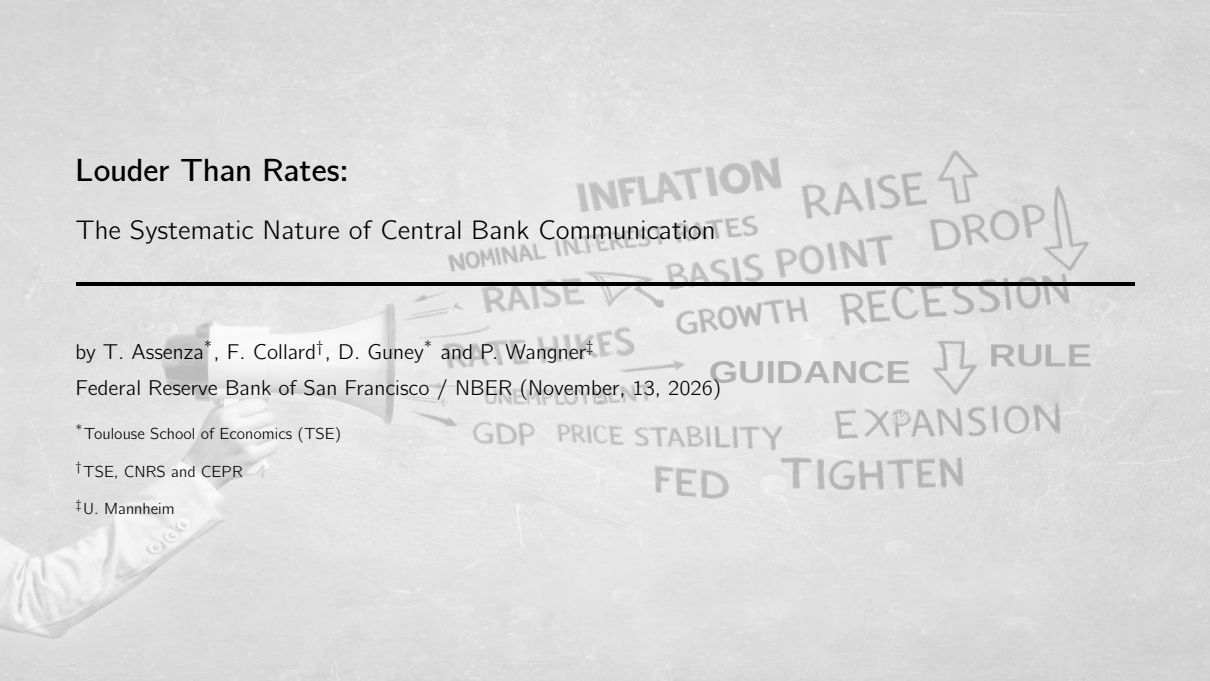
by T. Assenza*, F. Collard†, D. Guney* and P. Wangner‡

Federal Reserve Bank of San Francisco / NBER (November, 13, 2026)

*Toulouse School of Economics (TSE)

†TSE, CNRS and CEPR

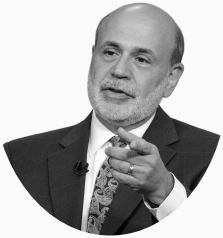
‡U. Mannheim



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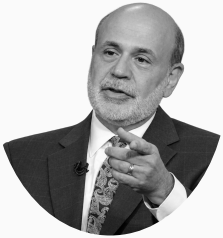


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  - → Interest rates respond to economic outlook.



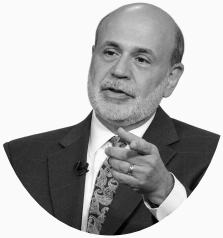
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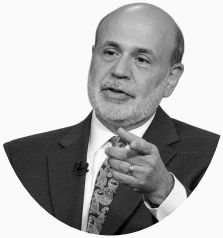
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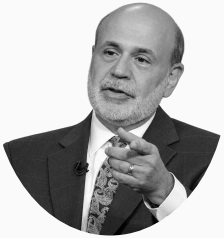
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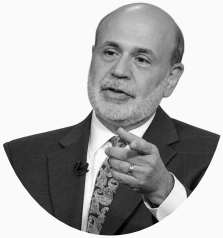
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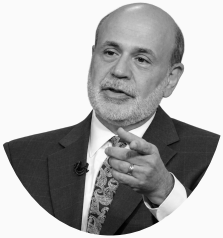
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- **Much less about how central banks decide when, why and how much to explain.**

Is there a systematic component in when/why a Central Bank decides to communicate more/less?

Does the CB's communication effort follow a rule?

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Does the CB's communication effort follow a rule?

- → Measuring the explanation effort: **Changes in Shannon Entropy**
- → Specifying/estimating a rule: **Taylor type rule**
- → If it does, does it shape macroeconomic dynamics? **Textbook NK + Imperfect Information**
  - → Stabilization property of monetary policy?
  - → Propagation of shocks (outside and at the ZLB)?

Preview of the Results

1. **Measure:** Quarterly change in entropy of FOMC statements as Fed's communication effort
   - **Not** tone (hawkish/dovish). **Not** sentiment. **Not** accuracy. **Not** quality.

Literature

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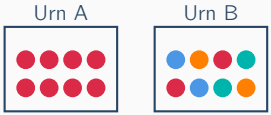
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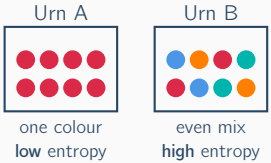
3. **Model:** 4-equation Communication RANK (CRANK)
   - **RANK** model enriched with **imperfect information** and **communication rule** as a second tool
   - **Countercyclical** communication ensures stability, resolves FG puzzle, and stabilizes activity at the ZLB

Literature

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  - Urn A: every draw predictable ⟶ no diversity ⟶ not informative
  - Urn B: even mix of color ⟶ diversity ⟶ each draw is informative
- Entropy: $\mathcal{E}(X_t) = -\sum_{x_i \in \mathcal{X}_t} p(x_i) \log_2 p(x_i)$



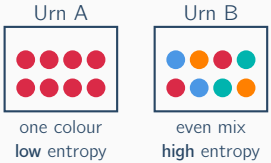
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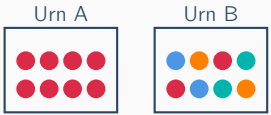
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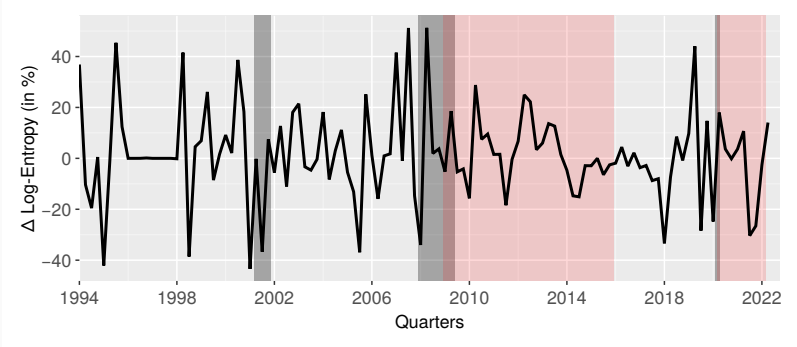
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- Time series of entropy $\mathcal{E}(X_t)$
  - High $\mathcal{E}(X_t)$: varied, informative language
  - Low $\mathcal{E}(X_t)$: repetitive, uninformative language

→ Communication effort $\Delta e_t = \Delta \log(\mathcal{E}(X_t))$

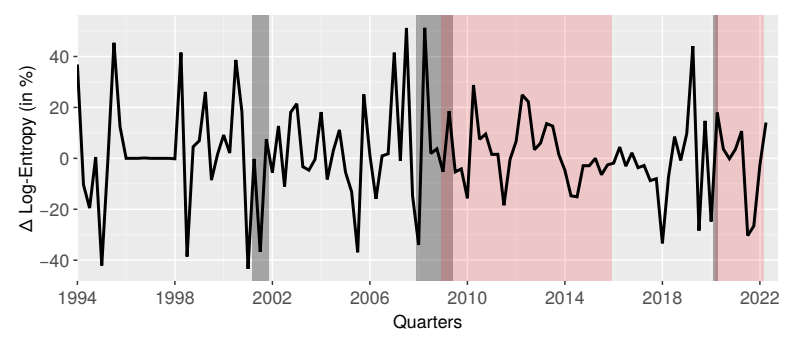
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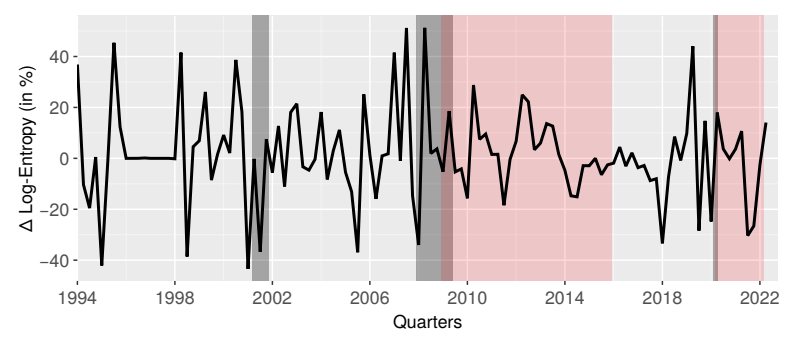


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  - Fed's communication is lexically not diverse

▸ Example

Measuring Communication Effort

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- Times of stress: More varied language → higher communication effort

- In the tradition of Taylor (1993), Clarida et al. (2000):

$$\begin{aligned} \Delta e_t &= \rho_e(L)\Delta e_{t-1} + (1-\overline{\rho}_e)\Delta e_t^* \\ \Delta e_t^* &= \Delta_e^* + \psi_\pi\left(\mathbb{E}\left[\pi_{t+k}|\mathcal{I}_t\right] - \pi^*\right) + \psi_y \mathbb{E}\left[\tilde{y}_{t+q,t}|\mathcal{I}_t\right] \end{aligned}$$

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  w/ π: annualized PCE inflation; $\tilde{y}$: CBO output gap, Baseline: **k=q=1**

- Estimate $(\rho_e, \pi^*, \psi_\pi, \psi_y)$ by iterated GMM (1994Q2–2022Q4). (Fix Δ_e^* to average)
- Instruments lagged values of Δe, π, $\tilde{y}$, shadow rate, commodity price inflation, M2 growth

A Communication Rule

▶ Baseline Specification

ρ_e	π^*	ψ_π	ψ_y	J-Test: p-value
0.07	1.93***	7.04***	-1.46**	0.28
(0.06)	(0.17)	(1.05)	(0.68)	

Note: HAC standard errors are reported in parentheses. Rightmost column: the p-value from the Sargan-Hansen over-identification test. *** (resp. ** and *) indicates statistical significance at the 1% (resp. 5% and 10%) level.

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→ Not rejected by the data! → There is a **systematic component** to communication effort.

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→ Little persistence (ρ_e) → driven by expected macroeconomic conditions rather than inertia.

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→ Inflation target (π^*) → aligns with Fed's announced target of 2%.

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→ Output feedback ($\psi_y < 0$) → Fed increases communication effort with output below potential.

- **Measurement:** Inflation, Output Gap ▶ Go
- **Expectations:** Varying the forecast horizon ($k, q \in \{0, \ldots, 4\}$), Tealbook forecasts ▶ Go

→ Never Rejected, Significant $\psi_\pi > 0$, Less precise ψ_y but always negative.

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- **Alternative Instrumental Strategy:** demand/supply shocks as external IVs Go

→ Never Rejected, Significant $\psi_\pi > 0$, $\psi_y < 0$ mainly driven by demand shocks.

Communication around the World

- Is this a US peculiarity?
- Re-estimate the rule for ECB, BoJ, Bank of Canada, RBA, Bank of Sweden Go
- **Bottomline:**
  - Very **robust** finding → Communication reflects the mandates
  - SOE specificity: communication tracks exchange rates
  - Canadian peculiarity: BoC explain US Fed policy!

Embedding Communication in a Simple Model

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  - Shocks are the outcome of a transitory $\boldsymbol{\omega_t}$ and a persistent $\boldsymbol{\tau_t}$ component
  - Households **observe** the shocks but **not each component** individually
  - Central bank sends a noisy public signal $\boldsymbol{s_t} = \boldsymbol{\tau_t} + \boldsymbol{\eta_t}$ with $\boldsymbol{\eta_t} \sim \mathcal{N}(0, \sigma_\eta^2(\Delta e_t)\Sigma_\eta)$ and $\sigma_\eta^{2\prime}(\cdot) < 0$
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- The rest of the model is **standard**:
  - Static NKPC: $\pi_t = \kappa y_t + \theta_t$ (Rotemberg + Aggregate reference prices)
  - Standard Taylor rule: $i_t = \phi_\pi \pi_t + \phi_y y_t$

- Using the Euler Equation + properties of log-normality of the shocks (in level)

→ DIS equation with two new terms (both vanish under FIRE):

$$y_t = \mathbb{E}_t[y_{t+1}] - \frac{1}{\gamma}(i_t - \mathbb{E}_t[\pi_{t+1}]) + \frac{x_t}{\gamma} + \boldsymbol{\Lambda_\delta \delta_t} + \frac{\chi_e}{\gamma}\Delta e_t$$

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- Mean-distortion channel: linked to signal extraction error $\boldsymbol{\delta_t} = \boldsymbol{\mu}^{\text{post}}_{\tau_t} - \boldsymbol{\tau_t}$ Go
  - household can't fully disentangle true shock from signal noise ($\boldsymbol{\eta}_t$) and transitory component ($\boldsymbol{\omega}_t$)

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  - household can't fully disentangle true shock from signal noise ($\boldsymbol{\eta}_t$) and transitory component ($\boldsymbol{\omega}_t$)
  - → **under-reaction** to current shocks
- Risk channel: linked to household's precautionary saving motive via $(\chi_e/\gamma)\Delta e_t$
  - More Com. → signal precision ↗ → posterior variance ↘ → savings ↘ and spending ↗

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\text{CP:} \quad & \Delta e_t = \psi_\pi \mathbb{E}_t[\pi_{t+1}] - \psi_y \mathbb{E}_t[y_{t+1}] \qquad \text{with } \psi_\pi > 0,\ \psi_y > 0
\end{aligned}$$

- An equivalence result: MP and CP are substitute → different levers, same gear.
- Stabilization → Eases local determinacy, mitigates the FG puzzle Go
- Propagation → Cyclicality affects propagation, ZLB management Go

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A: Yes! Raise communication effort with inflation and/or entering a recession.

- Consistent with the dual mandate of the FED, robust
- Extend to other CBs in the industrialized world
- When embedded in a standard NK model w/ imperfect information
  - Cyclicality of the rule is key to stabilize the economy (dual of the mandate matters)
  - Communication takes over the Taylor rule as a tool for ZLB resilience

THANK YOU!

Extras

- Correlations
- Intensive vs Extensive Margin
- Household problem
- Solution Output Dynamics
- Impulse Response Analysis
  - Analytical Expression
  - Sign
  - Shape
  - IS Shock
  - CP Shock
  - Stabilization vs Amplification

- Plugging NKPC and Com. Rule in DIS

$$y_t = \Theta \mathbb{E}_t[y_{t+1}] - \frac{1}{\gamma}(\imath_t - \mathbb{E}_t[\pi_{t+1}]) + \frac{x_t}{\gamma} + \mathbf{\Lambda}_{\boldsymbol{\delta}} \boldsymbol{\delta}_t + \frac{\chi_e \psi_\pi}{\gamma} \mathbb{E}_t[\theta_{t+1}]$$

with $\Theta = 1 + \frac{\chi_e}{\gamma}(\kappa \psi_\pi - \psi_y)$

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with $\Theta = 1 + \frac{\chi_e}{\gamma}(\kappa\psi_\pi - \psi_y)$

→ Discounting ($\Theta < 1$) if communication is countercyclical ($\psi_y > \kappa\psi_\pi$) (→ requires dual mandate)

→ Compounding ($\Theta > 1$) if communication is procyclical.

- By-product of communication policy.
- Estimated rule yields discounting

- Plugging NKPC and Com. Rule in DIS

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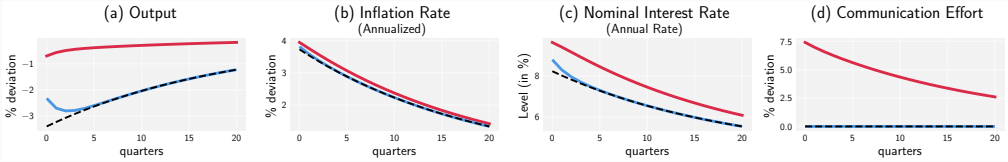
- By-product of communication policy.
- Estimated rule yields discounting

→ Relaxes the Taylor principle, resolves the FG puzzle

Go
Back

$$y_t = \boldsymbol{\Theta}\mathbb{E}_t[y_{t+1}] - \frac{1}{\gamma}(i_t - \mathbb{E}_t[\pi_{t+1}]) + \frac{x_t}{\gamma} + \boldsymbol{\Lambda}_{\boldsymbol{\delta}}\begin{pmatrix}\delta_t^x \\ \delta_t^\theta\end{pmatrix} + \frac{\chi_e \psi_\pi}{\gamma}\mathbb{E}_t[\theta_{t+1}]$$

A Positive Cost-Push Shock (+1%)

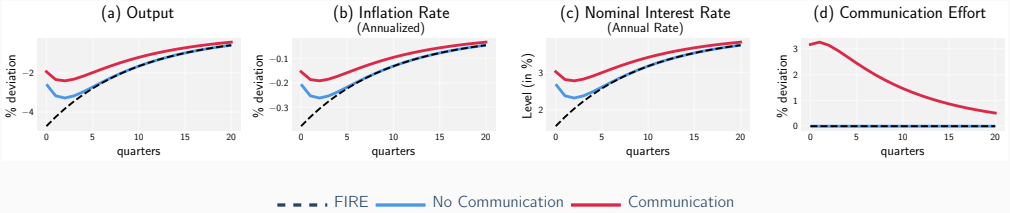


- The inflation response is positive at all horizons.
- The output response is negative if $\phi_\pi > \overline{\phi}_\pi$, positive if $\phi_\pi < \underline{\phi}_\pi$ and switches sign from negative to positive after h^* periods if $\underline{\phi}_\pi < \phi_\pi < \overline{\phi}_\pi$.
- **Trade-off:** Countercyclical communication stabilizes output at the price of small amplification of inflation.

◂ Back

$$y_t = \Theta \mathbb{E}_t[y_{t+1}] - \frac{1}{\gamma}(i_t - \mathbb{E}_t[\pi_{t+1}]) + \frac{x_t}{\gamma} + \mathbf{\Lambda}_{\boldsymbol{\delta}} \begin{pmatrix} \delta_t^x \\ \delta_t^\theta \end{pmatrix} + \frac{\chi_e \psi_\pi}{\gamma} \mathbb{E}_t[\theta_{t+1}]$$

A Negative IS Shock (-1%)



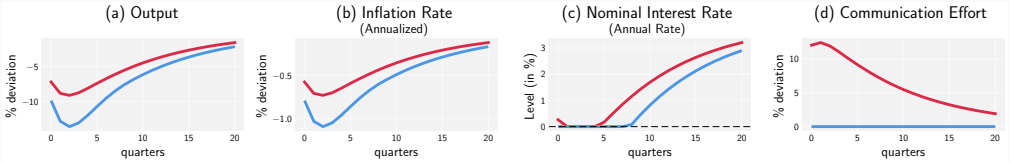
- The output and inflation responses have the sign of the shock at all horizons → Persistent component dominates mean distortion channel
- Countercyclical (procyclical) communication acts as an automatic stabilizer (amplifier).

◀ Back

The CRANK Model

▶ Propagation of IS Shocks at the ZLB

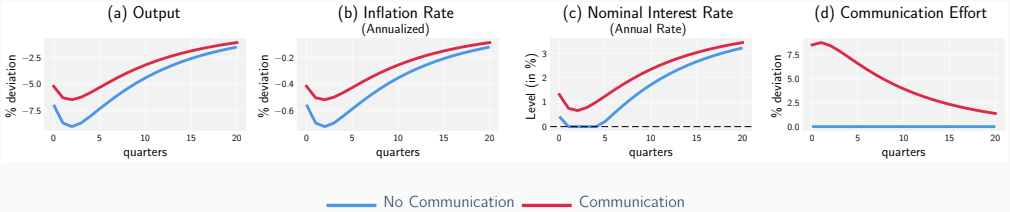
Large Negative IS Shock (-3.75%)



→ Communication mitigates the ZLB

◂ Back

Mild Negative IS Shock (-2.70%)



→ Communication prevents falling in the ZLB. Obtains only under a double mandate.

◂ Back

Related Literature

1. Measuring Central Bank Communication: FOMC statements as policy signals (Kuttner 2001, Bernanke and Kuttner 2005, Gürkaynak et al. 2005, Campbell et al. 2012), tone (Lucca & Trebbi 2009, Binder 2017), clarity (Hernández-Murillo and Shell 2014)

→ systematic communication (change in entropy) as opposed to discretionary communication

2. NLP Tools: text as data (Gentzkow et al. 2019), topic: latent Dirichlet allocation (Hansen and McMahon 2016b)

→ quantify supply-side communication effort, novelty, informational density

3. Systematic Rules: interest rate (Taylor 1993 & 1999), identification (Clarida et al. 2000, Barnichon and Mesters 2020), interest rate rules with communication (Lucca and Trebbi 2009, Shapiro and Wilson 2022, Gáti and Handlan 2024)

→ communication as dependent variable, GMM with internal and external IVs, no overfitting

4. NK Framework: RANK (Woodford 2003b, Galí 2015), noisy information (Woodford 2003a, Lorenzoni 2009), rational inattention (Sims 2003), second-order moments (Acharya and Dogra 2020), NK puzzles and solution (Debortoli et al. 2020, Del Negro et al. 2023, Gabaix 2020, Eggertsson and Schüle 2024)

→ CRANK with endogenous signal precision, countercyclical communication solves NK puzzles

◂ Back

Robustness Analysis

▶ Measurement

	Inflation				Output Gap	
	CPI	GDP Def.	Core PCE	Core CPI	Quadratic Trend	Unemployment Gap
ρ_e	0.02	-0.04	-0.11***	-0.12***	0.03	-0.10***
	(0.07)	(0.04)	(0.04)	(0.03)	(0.05)	(0.03)
π^*	2.46***	1.79***	1.83***	2.23***	1.82***	1.89***
	(0.16)	(0.16)	(0.23)	(0.16)	(0.14)	(0.27)
ψ_π	11.33***	7.13***	4.35***	5.54***	7.92***	3.50***
	(1.69)	(1.33)	(1.22)	(1.47)	(1.22)	(0.62)
ψ_y	-1.46	-1.12*	-0.61	-0.62	-1.49***	-0.57
	(1.09)	(0.64)	(0.56)	(0.55)	(0.34)	(0.51)
J-Test (p-val)	0.29	0.41	0.40	0.75	0.40	0.46

→ Not rejected by the data! There is a **systematic component** to communication.

◂ Back

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◂ Back

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→ Fed increases the informational content of its communication w/ expected inflation above target ($\psi_\pi > 0$)

◂ Back

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→ Same little persistence.

→ Inflation target aligns w/ FED's.

→ Fed increases the informational content of its communication w/ expected inflation above target ($\psi_\pi > 0$)

→ Conditional on π-exp., Fed raises information in recessions ($\psi_y < 0$), but less precise

◂ Back

	Varying Forecast Horizon			Tealbook	
	$k=0,\ q=0$	$k=4,\ q=4$	$k=4,\ q=1$	PCE	CPI
ρ_e	-0.12**	-0.04	-0.02	-0.18***	-0.17***
	(0.05)	(0.05)	(0.05)	(0.06)	(0.06)
π^*	1.83***	1.64***	1.62***	1.83***	1.93***
	(0.18)	(0.26)	(0.26)	(0.19)	(0.21)
ψ_π	5.72***	5.48***	5.60***	8.48**	7.74**
	(1.10)	(1.39)	(1.45)	(3.80)	(3.90)
ψ_y	-0.49	-1.43*	-1.19	-1.09*	-1.22**
	(0.48)	(0.78)	(0.73)	(0.59)	(0.60)
J-test	0.92	0.25	0.33	0.34	0.21
(p-val)					

Note: k is the lead on inflation, q is the lead in output.

→ Varying Expectation formation does not alter the main conclusions

→ Still not rejected by the data.

◀ Back

	Varying Forecast Horizon			Tealbook	
	$k = 0,\ q = 0$	$k = 4,\ q = 4$	$k = 4,\ q = 1$	PCE	CPI
ρ_e	-0.12**	-0.04	-0.02	-0.18***	-0.17***
	(0.05)	(0.05)	(0.05)	(0.06)	(0.06)
π^*	1.83***	1.64***	1.62***	1.83***	1.93***
	(0.18)	(0.26)	(0.26)	(0.19)	(0.21)
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→ Forecasting horizon does not alter response to inflation, Tealbook does not change direction but reinforces it.

◂ Back

	Varying Forecast Horizon			Tealbook	
	$k=0,\ q=0$	$k=4,\ q=4$	$k=4,\ q=1$	PCE	CPI
ρ_e	-0.12**	-0.04	-0.02	-0.18***	-0.17***
	(0.05)	(0.05)	(0.05)	(0.06)	(0.06)
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Note: k is the lead on inflation, q is the lead in output.

→ Varying Expectation formation does not alter the main conclusions

→ Still not rejected by the data.

→ Forecasting horizon does not alter response to inflation, Tealbook does not change direction but reinforces it.

→ Output not significant for shorter horizon, but still negative. Still significant w/ Tealbook.

◂ Back

Robustness Analysis

▶ External Instruments

	IV1.	IV2.	IV3.
ρ_e	-0.06	-0.27*	-0.12***
	(0.09)	(0.15)	(0.04)
π^*	1.72***	1.66**	1.79***
	(0.26)	(0.65)	(0.31)
ψ_π	6.73**	7.97***	3.82***
	(2.67)	(2.95)	(1.28)
ψ_y	0.13	-14.41**	-3.65*
	(2.43)	(6.26)	(1.96)
J-test. (p-val)	0.32	0.48	0.11

- Use external instruments ⟶ lags of Shocks
  - IV1: Kanzig's oil price shocks ⟶ Supply
  - IV2: Nakamura-Steinson's MP shocks ⟶ Demand
  - IV3: Combination of both

◂ Back

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- Use external instruments → lags of Shocks
  - IV1: Kanzig's oil price shocks → Supply
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  - IV3: Combination of both
- Reaction to supply driven fluctuations
  - Significant and strong reaction to inflation
  - No reaction to output gap

  → More need to clarify the role of Supply Shocks on inflation

◂ Back

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  - Significant and strong reaction to inflation
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  → More need to clarify the role of Supply Shocks on inflation
- Reaction to demand driven fluctuations
  - Still significant reaction to inflation
  - But clear need to explain action in demand driven recessions

◂ Back

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- Reaction to demand driven fluctuations
  - Still significant reaction to inflation
  - But clear need to explain action in demand driven recessions
- Both instruments → Combination

◂ Back

- Decompose:

$$\log \mathcal{E}(X_t) = \underbrace{\log L_t}_{\text{length} \to \text{extensive margin}} + \underbrace{\log(\mathcal{E}(X_t)/L_t)}_{\text{density} \to \text{intensive margin}} \tag{1}$$

- Re-estimate the rule with length ($\Delta logL_t$):

ρ_e	π^*	ψ_π	ψ_y	J-Test: p-value
-0.08*	2.38***	4.07*	-1.03	0.35
(0.04)	(0.33)	(0.95)	(0.78)	

- The dual-mandate signal lives in the intensive margin: **how it's written, not how long**. Length alone $\Rightarrow$ a Fed that looks like a strict inflation targeter.

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Communication around the World

Rule	Parameters						J-Test
	ρ_e	π^*	ψ_π	ψ_y	ψ_r	$\psi_{\Delta s}$	p-value
US: 1994Q1-2022Q4							
Baseline	0.07	1.93***	7.04***	-1.46**	–	–	0.28
	(0.06)	(0.17)	(1.05)	(0.68)			
Euro Area: 2000Q1-2022Q4							
Baseline	-0.07	2.24***	3.82**	-0.27	–	–	0.23
	(0.07)	(0.54)	(1.91)	(0.59)			
Japan: 2003Q2-2022Q4							
Baseline	-0.38***	0.46*	7.16**	-3.47**	–	–	0.46
	(0.08)	(0.28)	(3.06)	(1.67)			
Canada: 1998Q1-2022Q4							
Baseline	-0.24***	2.28	0.37	1.37**	–	–	0.15
	(0.05)	(1.79)	(1.18)	(0.58)			
Australia: 1992Q1-2022Q4							
Baseline	-0.02	2.30***	4.99**	-5.28**	–	–	0.74
	(0.08)	(0.23)	(2.52)	(2.46)			
Sweden: 2000Q1-2022Q4							
Baseline	-0.54***	0.87**	1.01***	-1.36***	–	–	0.14
	(0.04)	(0.40)	(0.20)	(0.30)			

◂ Back

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	ρ_e	π^*	ψ_π	ψ_y	ψ_r	$\psi_{\Delta s}$	p-value
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Japan: 2003Q2-2022Q4							
Baseline	-0.38***	0.46*	7.16**	-3.47**	–	–	0.46
	(0.08)	(0.28)	(3.06)	(1.67)			
Canada: 1998Q1-2022Q4							
Extended	-0.19***	1.81***	–	–	1.28**	–	0.20
	(0.05)	(0.41)			(0.26)		
Australia: 1992Q1-2022Q4							
Baseline	-0.02	2.30***	4.99**	-5.28**	–	–	0.74
	(0.08)	(0.23)	(2.52)	(2.46)			
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Baseline	-0.54***	0.87**	1.01***	-1.36***	–	–	0.14
	(0.04)	(0.40)	(0.20)	(0.30)			

◂ Back

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	(0.05)	(0.41)			(0.26)		
Australia: 1992Q1-2022Q4							
Extended	-0.18*	2.07***	2.02**	-3.97***	–	0.71***	0.14
	(0.09)	(0.53)	(0.98)	(1.33)		(0.26)	
Sweden: 2000Q1-2022Q4							
Extended	-0.11**	1.83***	1.05***	-1.10***	–	0.17***	0.48
	(0.05)	(0.31)	(0.21)	(0.24)		(0.04)	

◂ Back

Bayesian updating as two sequential steps (order is immaterial):

1. Household reads fundamentals: Pre-communication belief $\boldsymbol{\tau}_t \mid \boldsymbol{z}_t, \mathcal{I}_{t-1} \sim \mathcal{N}(\boldsymbol{m}_t, \boldsymbol{P})$ with

$$\boldsymbol{m}_t = \boldsymbol{\mu}_{\tau_t}^{\text{prior}} + \boldsymbol{G}(\boldsymbol{z}_t - \boldsymbol{\mu}_{\tau_t}^{\text{prior}}) , \quad \boldsymbol{P} = (\boldsymbol{I} - \boldsymbol{G})\boldsymbol{\Sigma}_{\tau}^{\text{prior}} , \quad \boldsymbol{G} \equiv \boldsymbol{\Sigma}_{\tau}^{\text{prior}}(\boldsymbol{\Sigma}_{\tau}^{\text{prior}} + \boldsymbol{\Sigma}_{\omega})^{-1}$$

   $\boldsymbol{I}$ is identity matrix, $\boldsymbol{G}$ gain on fundamentals, $\boldsymbol{P}$ residual variance

2. Household reads central bank's signal: Posterior belief $\boldsymbol{\tau}_t^{\text{post}} \equiv \boldsymbol{\tau}_t \mid \boldsymbol{z}_t, \boldsymbol{s}_t, \mathcal{I}_{t-1} \sim \mathcal{N}(\boldsymbol{\mu}_{\tau_t}^{\text{post}}, \boldsymbol{\Sigma}_{\tau_t}^{\text{post}})$ with

$$\boldsymbol{\mu}_{\tau_t}^{\text{post}} = \boldsymbol{m}_t + \boldsymbol{K}_t(\boldsymbol{s}_t - \boldsymbol{m}_t) , \quad \boldsymbol{\Sigma}_{\tau_t}^{\text{post}} = (\boldsymbol{I} - \boldsymbol{K}_t)\boldsymbol{P} = \boldsymbol{K}_t\sigma_{\eta}^2(\Delta e_t)\boldsymbol{\Sigma}_{\eta} , \quad \boldsymbol{K}_t \equiv \boldsymbol{P}\big(\boldsymbol{P} + \sigma_{\eta}^2(\Delta e)\boldsymbol{\Sigma}_{\eta}\big)^{-1}$$

   $\boldsymbol{K}$ is communication Kalman gain

Assumption: households update beliefs with steady-state Kalman gains, evaluated at Δe:

- Δe affects signal precision and belief accuracy, but not the weight households place on it
- If $\sigma_{\eta}^2 \to 0$, then $\boldsymbol{K} \to \boldsymbol{I}$ and $\boldsymbol{\mu}_{\tau_t}^{\text{post}} \to \boldsymbol{\mu}_{\tau_t}^{\text{prior}}$; If $\sigma_{\eta}^2 \to \infty$, then $\boldsymbol{K} \to \boldsymbol{0}$ and $\boldsymbol{\mu}_{\tau_t}^{\text{post}} \to \boldsymbol{m}_t$

◂ Back

- Gap between belief and truth is the **signal-extraction error**:

$$\delta_t \equiv \mu_{\tau_t}^{\text{post}} - \tau_t = \underbrace{K_t \eta_t + (I - K_t) G \omega_t}_{\text{① noise taken for a shock}} - \underbrace{(I - K_t)(I - G)(\tau_t - \mu_{\tau_t}^{\text{prior}})}_{\text{② under-reaction to true shock}}$$

- ①: agents partly read signal noise as a genuine shock $\Rightarrow$ noise-driven fluctuations
- ②: they revise by only a fraction $1 - (I - K_t)(I - G)$ of the true innovation $\Rightarrow$ under-reaction

$\rightarrow$ Both vanish as communication improves: $K_t \to I$ and $\Sigma_\eta \to 0$

Proposition (Signal Extraction Error)

The signal extraction error $\boldsymbol{\delta}_t$ *follows an autoregressive process of the form*

$$\boldsymbol{\delta}_t = D_\varrho \boldsymbol{\delta}_{t-1} + M_e \mathcal{E}_t \,,$$

where $D_\varrho = \mathrm{diag}(\varrho_\theta, \varrho_x)$ *with* $\varrho_i = \rho_i(1-\Gamma_i) < \rho_i$, *where* $1-\Gamma_i \equiv (1-k_i)(1-G_i)$, $\mathcal{E}_t = (\varepsilon_t^\theta, \varepsilon_t^x, \omega_t^\theta, \omega_t^x, \eta_t^\theta, \eta_t^x)'$ *and*

$$M_e = \begin{pmatrix} -(1-k_\theta)(1-G_\theta) & 0 & (1-k_\theta)G_\theta & 0 & k_\theta & 0 \\ 0 & -(1-k_x)(1-G_x) & 0 & (1-k_x)G_x & 0 & k_x \end{pmatrix} .$$

◀ Back

Proposition (Local Determinacy)

The model admits a locally stable solution if the following condition is satisfied:

$$-2\gamma - \kappa(1+\phi_\pi) - \phi_y \;<\; \chi_e\left[\kappa\psi_\pi - \psi_y\right] \;<\; \kappa(\phi_\pi - 1) + \phi_y \,.$$

- Acyclical Communication ➞ Standard RANK: for $\psi_\pi = \psi_y = 0$ collapses to

$$\kappa(\phi_\pi - 1) + \phi_y \;>\; 0$$

- Communication shifts lower bound by $\chi_e[\kappa\psi_\pi - \psi_y]$
  - Direction of shift is determined by the sign of $\kappa\psi_\pi - \psi_y$ ➞ Countercyclical Com. relaxes it.
  - Scales with χ_e: a more effective communicator has larger influence on determinacy region

◂ Back

- Interest rate policy exhausted: $\phi_\pi = \phi_y = 0 \rightarrow$ Determinacy condition simplifies to:

$$-2\gamma - \kappa \; < \; \chi_e \left[\kappa\psi_\pi - \psi_y\right] \; < \; -\kappa \quad \Leftrightarrow \quad -1 < \boldsymbol{\Theta} + \frac{\kappa}{\gamma} < 1$$

- Standard NK model $\boldsymbol{\Theta} = 1 \Rightarrow$ multiplier $1 + \frac{\kappa}{\gamma} > 1 \Rightarrow$ **indeterminate** (deflationary spiral)

- Dual mandate + Countercyclical communication $\rightarrow \boldsymbol{\Theta} < 1 \rightarrow$ multiplier inside $(-1, 1) \Rightarrow$ **determinate**

- Inflation-only communication ($\psi_y = 0$) is destabilizing as it amplifies the spiral

Change in Entropy between Two Consecutive FOMC Statements

▶ Example

September, 16, 2003: The Federal Open Market Committee decided today to keep its target for the federal funds rate at 1 percent. The Committee continues to believe that an accommodative stance of monetary policy, coupled with robust underlying growth in productivity, is providing important ongoing support to economic activity. The evidence accumulated over the intermeeting period confirms that spending is firming, although the labor market has been weakening. Business pricing power and increases in core consumer prices remain muted. The Committee perceives that the upside and downside risks to the attainment of sustainable growth for the next few quarters are roughly equal. In contrast, the probability, though minor, of an unwelcome fall in inflation exceeds that of a rise in inflation from its already low level. The Committee judges that, on balance, the risk of inflation becoming undesirably low remains the predominant concern for the foreseeable future. In these circumstances, the Committee believes that policy accommodation can be maintained for a considerable period.

October, 28, 2003: The Federal Open Market Committee decided today to keep its target for the federal funds rate at 1 percent. The Committee continues to believe that an accommodative stance of monetary policy, coupled with robust underlying growth in productivity, is providing important ongoing support to economic activity. The evidence accumulated over the intermeeting period confirms that spending is firming, and the labor market appears to be stabilizing. Business pricing power and increases in core consumer prices remain muted. The Committee perceives that the upside and downside risks to the attainment of sustainable growth for the next few quarters are roughly equal. In contrast, the probability, though minor, of an unwelcome fall in inflation exceeds that of a rise in inflation from its already low level. The Committee judges that, on balance, the risk of inflation becoming undesirably low remains the predominant concern for the foreseeable future. In these circumstances, the Committee believes that policy accommodation can be maintained for a considerable period.

→ Change in log-entropy: 0.12%; statement length identical: 89 n-grams

◂ Back

Household Problem

$$\max_{\{c_t, n_t, b_{t+1}\}} \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\frac{c_t^{1-\gamma}}{1-\gamma} - \nu \frac{n_t^{1+\varphi}}{1+\varphi} \right) \right] \quad \text{s.t.} \quad c_t + b_{t+1} = \frac{R_{t-1}}{\exp(x_{t-1})\pi_t} b_t + w_t n_t + d_t$$

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$$\max_{\{c_t, n_t, b_{t+1}\}} \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\frac{c_t^{1-\gamma}}{1-\gamma} - \nu \frac{n_t^{1+\varphi}}{1+\varphi} \right) \right] \quad \text{s.t.} \quad c_t + b_{t+1} = \frac{R_{t-1}}{\exp(x_{t-1})\pi_t} b_t + w_t n_t + d_t$$

- Labor supply: $c_t^{-\gamma} w_t = \nu n_t^{\varphi}$

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$$\max_{\{c_t, n_t, b_{t+1}\}} \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\frac{c_t^{1-\gamma}}{1-\gamma} - \nu \frac{n_t^{1+\varphi}}{1+\varphi} \right) \right] \quad \text{s.t.} \quad c_t + b_{t+1} = \frac{R_{t-1}}{\exp(x_{t-1})\pi_t} b_t + w_t n_t + d_t$$

- Labor supply: $c_t^{-\gamma} w_t = \nu n_t^{\varphi}$
- Euler equation (under posterior belief): $c_t^{-\gamma} = \beta \frac{R_t}{\exp(x_t)} \mathbb{E}_t^{\text{post}} \left[\frac{c_{t+1}^{-\gamma}}{\pi_{t+1}} \right]$

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$$\max_{\{c_t, n_t, b_{t+1}\}} \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\frac{c_t^{1-\gamma}}{1-\gamma} - \nu \frac{n_t^{1+\varphi}}{1+\varphi} \right) \right] \quad \text{s.t.} \quad c_t + b_{t+1} = \frac{R_{t-1}}{\exp(x_{t-1})\pi_t} b_t + w_t n_t + d_t$$

- Labor supply: $c_t^{-\gamma} w_t = \nu n_t^{\varphi}$
- Euler equation (under posterior belief): $c_t^{-\gamma} = \beta \frac{R_t}{\exp(x_t)} \mathbb{E}_t^{\text{post}} \left[\frac{c_{t+1}^{-\gamma}}{\pi_{t+1}} \right]$
  - In log-linear terms: $c_t = \underbrace{\mathbb{E}_t^{\text{post}}[c_{t+1}] - \frac{1}{\gamma}(i_t - \mathbb{E}_t^{\text{post}}[\pi_{t+1}]) + \frac{1}{\gamma} x_t}_{1^{\text{st}}\text{-order moment}} - \underbrace{\frac{1}{\gamma} \Omega_t^{\text{post}}}_{2^{\text{nd}}\text{-order moment}}$

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$$\max_{\{c_t, n_t, b_{t+1}\}} \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\frac{c_t^{1-\gamma}}{1-\gamma} - \nu \frac{n_t^{1+\varphi}}{1+\varphi} \right) \right] \quad \text{s.t.} \quad c_t + b_{t+1} = \frac{R_{t-1}}{\exp(x_{t-1})\pi_t} b_t + w_t n_t + d_t$$

- Labor supply: $c_t^{-\gamma} w_t = \nu n_t^{\varphi}$
- Euler equation (under posterior belief): $c_t^{-\gamma} = \beta \frac{R_t}{\exp(x_t)} \mathbb{E}_t^{\text{post}} \left[\frac{c_{t+1}^{-\gamma}}{\pi_{t+1}} \right]$
  - In log-linear terms: $c_t = \underbrace{\mathbb{E}_t^{\text{post}}[c_{t+1}] - \frac{1}{\gamma}(i_t - \mathbb{E}_t^{\text{post}}[\pi_{t+1}]) + \frac{1}{\gamma} x_t}_{1^{\text{st}}\text{-order moment}} - \underbrace{\frac{1}{\gamma}\Omega_t^{\text{post}}}_{2^{\text{nd}}\text{-order moment}}$
  - Communication affects 2^{nd}-order moment: $\Omega_t^{\text{post}} \approx -\chi_e \Delta e_t$ with effectiveness $\chi_e > 0$

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Proposition (Output Dynamics)

At the locally determinate solution, the output dynamics are linear in the persistent components, τ_t^i, the signal extraction errors, δ_t^i, and the transitory components, ω_t^i:

$$\widehat{y}_t \;=\; \zeta_\theta\,\tau_t^\theta + \zeta_x\,\tau_t^x \;+\; \xi_\theta\,\delta_t^\theta + \xi_x\,\delta_t^x \;-\; \frac{\phi_\pi}{\Delta}\,\omega_t^\theta + \frac{1}{\Delta}\,\omega_t^x\,,$$

where the cost-push and DIS loadings are given by

$$\zeta_\theta = \frac{(1+\chi_e\psi_\pi)\rho_\theta - \phi_\pi}{\Delta(1-\rho_\theta\mathcal{M})}\,, \quad \xi_\theta = \frac{\rho_\theta\big[(\gamma+\kappa)\zeta_\theta + 1\big]}{\Delta_\theta}\,,$$
$$\zeta_x = \frac{1}{\Delta(1-\rho_x\mathcal{M})}\,, \quad \xi_x = \frac{\rho_x(\gamma+\kappa)\zeta_x}{\Delta_x}\,,$$

with the auxiliary parameters

$$\Delta = \gamma + \kappa\phi_\pi + \phi_y > 0\,, \quad \textit{and} \quad \Delta_i \;\equiv\; \Delta + \chi_e\big(\psi_y - \kappa\psi_\pi\big)\rho_i(1-\Gamma_i) > 0 \quad \textit{for} \;\; i\in\{\theta,x\}\,.$$

◀ Back

The impulse responses of output, $m_{y,i}(h)$, and inflation, $m_{\pi,i}(h)$, h periods after an initial shock to the persistent component of the fundamental, ϵ_0^i, are given by

$$m_{y,i}(h) \equiv \rho_i^h \left[\zeta_i - \xi_i(1-\Gamma_i)^{h+1}\right] \quad , \quad m_{\pi,i}(h) \equiv \kappa m_{y,i}(h) + \rho_\theta^h \mathbb{1}_{\{i=\theta\}} \ .$$

- response to persistent component and signal extraction error pull in opposite directions
- ambiguous signs of inflation and output multipliers

Corollary (Sign)

There exist $\underline{\phi}_\pi$ and $\overline{\phi}_\pi$, with $\underline{\phi}_\pi < \overline{\phi}_\pi$ such that

1. *The output and inflation responses to a positive DIS shock are positive at all horizons, i.e., $m_{\pi,x}(h) > 0$ and $m_{y,x}(h) > 0 \ \forall h \geq 0$.*

2. *The inflation response to a positive cost-push shock is positive at all horizons, i.e., $m_{\pi,\theta}(h) > 0 \ \forall h \geq 0$. The sign of the output response satisfies:*

   i. *$m_{y,\theta}(h) < 0 \ \forall h \geq 0$ if $\phi_\pi \geq \overline{\phi}_\pi$;*

   ii. *$m_{y,\theta}(h) \geq 0 \ \forall h \geq 0$ if $\phi_\pi \leq \underline{\phi}_\pi$;*

   iii. *if $\underline{\phi}_\pi < \phi_\pi < \overline{\phi}_\pi$, there exists $h^*_\theta > 0$ such that $m_{y,\theta}(h) \lesseqgtr 0$ for $h \lesseqgtr h^*_\theta$.*

◀ Back

Corollary (Stabilization vs Amplification)

The following two statements hold.

1. *Following a DIS shock, we obtain for any horizon h:*

$$sgn(m^{C}_{y,x}(h) - m^{NC}_{y,x}(h)) = sgn(m^{C}_{\pi,x}(h) - m^{NC}_{\pi,x}(h)) = sgn(\Theta - 1) \ .$$

2. *Following a cost push shock, we obtain for any horizon h:*

$$sgn(m^{C}_{y,\theta}(h) - m^{NC}_{y,\theta}(h)) = sgn(m^{C}_{\pi,\theta}(h) - m^{NC}_{\pi,\theta}(h)) > 0 \ .$$

◀ Back

Corollary (Shape of Output Response)

Define $\lambda_i \equiv \ln(\rho_i)/\ln(\rho_i(1-\Gamma_i)) \in (0,1)$ *and the critical cyclicality of communication*

$$\Theta_i^{crit} \equiv 1 + \frac{\Delta}{\gamma(1-\Gamma_i)\rho_i} - \frac{\gamma+\kappa}{\gamma\lambda_i} + \mathbb{1}_{\{i=\theta\}}\frac{K_\theta}{\gamma(\lambda_\theta N_\theta - \rho_\theta)}, \qquad K_\theta \equiv \frac{\Delta\,\Gamma_\theta}{1-\Gamma_\theta} - \frac{(\gamma+\kappa)\rho_\theta(1-\lambda_\theta)}{\lambda_\theta},$$

where $i \in \{x,\theta\}$, $N_\theta \equiv (1+\chi_e\psi_\pi)\rho_\theta - \phi_\pi \notin \{0, \rho_\theta/\lambda_\theta\}$, *and let* $\varepsilon_x \equiv 1$ *and* $\varepsilon_\theta \equiv 1 - \rho_\theta/(\lambda_\theta N_\theta)$.

1. *If* $\varepsilon_i(\Theta - \Theta_i^{crit}) \leqslant 0$, *the output response is monotone.*
2. *If* $\varepsilon_i(\Theta - \Theta_i^{crit}) > 0$, *the response is hump-shaped (trough-shaped if* $\zeta_i < 0$*) and has a unique interior extremum, with the same sign as* ζ_i, *at*

$$h_i^\star = \frac{\ln\left(1 + \gamma(1-\Gamma_i)\rho_i\,\varepsilon_i(\Theta - \Theta_i^{crit})/\Delta_i\right)}{\ln\left(1/(1-\Gamma_i)\right)} > 0\,.$$

Correlation Analysis

			Nakamura	Gurkaynak, Sack, and Swanson (2005)	
Δ Flesh-Kincaid	Hawkish/Dovish	MPU	Steinsson (2018)	Target	Path
0.06	0.03	-0.01	0.12	0.11	0.06

Note: Target is the target series of monetary policy surprises, corresponding to the instrument set's first principal component that is rotated so that it drives unexpected changes in the current target federal funds rate. Path is the path series of monetary policy surprises corresponding to the instrument set's second principal component rotated so that it has no effect, on average, on the current month's federal funds futures.

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