# Inflation Disagreements and the Transmission of Monetary Policy

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[1]The views expressed herein are those of the authors and do not necessarily reflect those of the Federal Reserve Bank of San Francisco, of the Federal Reserve Board or of the Federal Reserve System.

"Inflation expectations are terribly important. We spend a lot of time watching them."

Jerome Powell, Federal Reserve Chair (2021)

# Inflation expectation

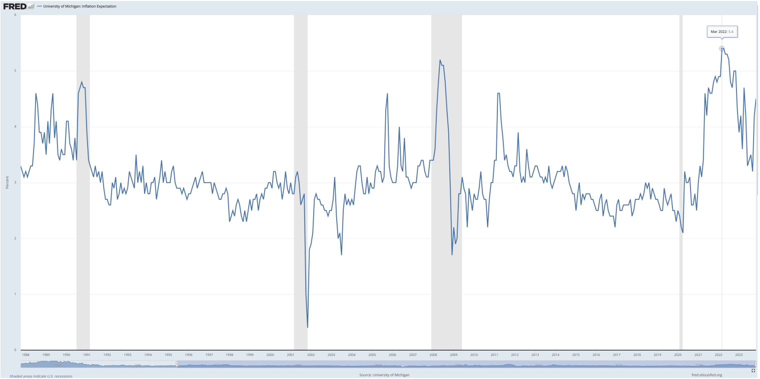


Figure: Household inflation expectation (1988-2022)

Data source: Michigan Survey of Consumers, IQR of 1-year ahead inflation expectation

# Inflation expectation dispersion

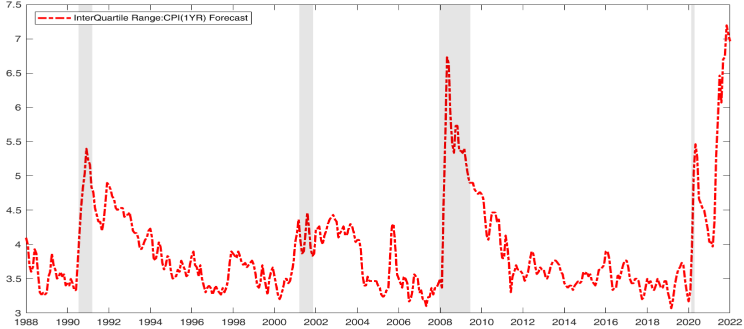


Figure: Household inflation expectation disagreement (1988-2022)

Data source: Michigan Survey of Consumers, 1-year ahead inflation

# Inflation expectation dispersion

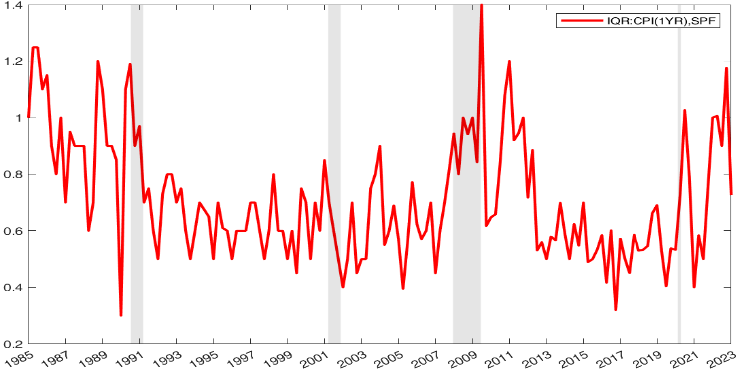


Figure: Professional inflation expectation disagreement (1985-2023)

Data source: Survey of Professional Forecasters, 1-year ahead inflation

# Inflation expectation and monetary policy

- Inflation expectations are not anchored
- What's well known: inflation expectation and monetary policy transmission
- What's less known: inflation expectation disagreement and monetary policy transmission
- This paper (theory + empiric): the role of inflation disagreement in
  1. transmission of conventional monetary policy (e.g. target)
  2. transmission of unconventional mp (e.g. forward guidance)
- "High inflation disagreements weaken the potency of MP."

# Preview: Theory

- Tractable GE model with
  1. heterogeneous belief on future inflation
  2. liquidity constraint
- Heterogeneous belief on inflation:
  1. HH on the higher tail $\rightarrow$ low perceived real interest rate
     $\rightarrow$ high MPC, *s.t. liquidity constraint* ($\rightarrow$ *endo hand-to-mouth*)
     $\rightarrow$ less sensitive to (current & future) interest rate changes
  2. lower inflation expectation $\rightarrow$ lower MPC
- Inflation expectation heterogeneity $\uparrow$ $\rightarrow$ share of H2M household $\uparrow$ $\rightarrow$ effect of MP on aggregate C $\downarrow$
- Discounted Euler equation w. micro-foundation:

$$\hat{C}_t = \beta_1 \mathbb{E}_t \hat{C}_{t+1} - \beta_2 \left( \hat{r}_{ft} - \mathbf{E}_t \hat{\pi}_{t+1} \right) \tag{1}$$

  1. micro-founded $\beta_1$: decreases with inflation disagreement
  2. micro-founded $\beta_2$: decreases with inflation disagreement

# Empirical evidence for

- Model mechanisms
  1. Positive relations between individual inflation expectations and current consumption spending.
  2. Negative relation between household indebtedness and the effectiveness of monetary policy.

- Model predictions

$$\hat{C}_t = \beta_1 \mathbb{E}_t \hat{C}_{t+1} - \beta_2 \left( \hat{r}_{ft} - \mathbf{E}_t \hat{\pi}_{t+1} \right)$$

We use local projection to show

1. ($\beta_1$) effectiveness of forward guidance shock on current economic activity /inflation decreases with inflation disagreement.
2. ($\beta_2$) effectiveness of federal rate shock on current economic activity /inflation decreases with inflation disagreement.

# Forward Guidance Puzzle

# Textbook NK model

Standard Euler equation derived from textbook NK model with log-utility:

$$\frac{1}{C_t} = \beta R_{ft} E_t \frac{1}{C_{t+1}} \frac{1}{\Pi_{t+1}},$$

The log-linearized Euler equation:

$$\hat{C}_t = E_t \hat{C}_{t+1} - (\hat{R}_{ft} - E_t \hat{\Pi}_{t+1}),$$

Iterating the Euler equation forward:

$$\hat{C}_t = -\sum_{j=0}^{\infty} E_t (\hat{R}_{ft+j} - E_t \hat{\Pi}_{t+j+1}). \tag{2}$$

(Forward guidance puzzle) Far future policy rate change have an implausibly large effect on current consumption as comtemporenous policy rate change.

# A Tractable Heterogeneous-agent Model

- Household:
    - family: supply homogeneous labor, homogeneous transfer to each member
    - member: w. heterogeneous inflation expectation, consumption-saving decision
- Firm: standard as textbook NK model
- Monetary authority: standard as textbook NK model
- Forward guidance puzzle solved:

$$\hat{C}_t = \beta_1 E_t \hat{C}_{t+1} - \beta_2 (\hat{R}_{ft} - E_t \hat{\Pi}_{t+1}),$$

# MP rule and household expectation

Assume that the monetary policy rule follows

$$R_{ft} = R_0 \Pi_t^* \left( \frac{\Pi_t}{\Pi_t^*} \right)^{\varphi} \exp(\xi_t), \qquad \varphi > 1, \tag{3}$$

- $R_0$: the natural rate of real interest rate (constant)
- $\Pi_t^*$: inflation target of monetary authority;
- $\xi_t$: monetary policy shock.

We assume the true process of targeted inflation is

$$\Pi_{t+1}^* = \Pi_t^* \exp(\varepsilon_{t+1}), \tag{4}$$

where true $\varepsilon_{t+1}$ is a constant of 0.
However, each agent j forms different belief about $\varepsilon_{t+1}$, such that

$$E_t^j \frac{\Pi_{t+1}^*}{\Pi_t^*} = e_{jt}, \tag{5}$$

and $e$ follows an i.i.d. distribution with C.D.F. $G(e)$.

# Household's problem

The household's welfare:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[ \int_0^1 \log C_{jt}\, dj - \psi \frac{N_t^{1+\gamma}}{1+\gamma} \right]$$

subject to

1. (family) budget constraint:

$$Y_t \leq \frac{\int_0^1 B_{jt}\, dj}{P_t} + \frac{W_t}{P_t} N_t + D_t, \tag{6}$$

2. (individual) portfolio constraint

$$C_{jt} + \frac{B_{jt+1} / R_{ft}}{P_t} \leq Y_t, \tag{7}$$

3. (individual) liquidity constraint

$$\frac{B_{jt+1} / R_{ft}}{P_t} \geq -\bar{B} \tag{8}$$

$\bar{B}$ is exogenous and cannot exceed $Y_t$

# Euler equation

First-order conditions:

1. w.r.t. aggregate labor:

$$\Lambda_t \frac{W_t}{P_t} = \psi N_t^{\gamma}, \quad \textit{where} \quad \Lambda_t = \int_0^1 \Lambda_{jt} dj = \int_0^1 \frac{1}{C_{jt}} dj, \tag{9}$$

   $\Lambda_{jt}$: marginal utility from consumption.

2. w.r.t. nominal saving: ($\Omega_{jt}$: multiplier associated with liquidity constraint. )

$$\Lambda_{jt} = \beta R_{ft} \mathbb{E}_t^j \frac{\Lambda_{t+1}}{\Pi_{t+1}} + \Omega_{jt} \quad \forall j \tag{10}$$

   Define "consensus" rates: $r_{ft} = R_{ft}/\Pi_t^*$ and $\pi_t = \Pi_t/\Pi_t^*$:

$$\Lambda_{jt} = \beta r_{ft} \mathbb{E}_t^j \left[ \frac{\Lambda_{t+1}}{\pi_{t+1}} \frac{\Pi_t^*}{\Pi_{t+1}^*} \right] + \Omega_{jt} \equiv \beta \frac{1}{e_{jt}} r_{ft} \mathbb{E}_t \left[ \frac{\Lambda_{t+1}}{\pi_{t+1}} \right] + \Omega_{jt}. \tag{11}$$

# Consumption

1. Marginal consumer (saver) as $e_t^*$, s.t. $\Omega_{jt}(e_t^*) = 0$

$$\frac{1}{\bar{C}_t} = \frac{\beta}{e_t^*} r_{ft} \mathbb{E}_t \left[ \frac{\Lambda_{t+1}}{\pi_{t+1}} \right] \tag{12}$$

   where $\bar{C}_t = Y_t + \bar{B}$ is the maximum consumption level.

2. Family members with $e_{jt} > e_t^*$ face binding constraint ($\Omega_{jt} > 0$)

$$C_{jt} = Y_t + \bar{B} \equiv \bar{C}_t, \qquad \forall e_{jt} > e_t^* \tag{13}$$

3. Family members with $e_{jt} \leq e_t^*$,

$$\frac{1}{C_{jt}} = \frac{\beta}{e_{jt}} r_{ft} \mathbb{E}_t \left[ \frac{\Lambda_{t+1}}{\pi_{t+1}} \right] \tag{14}$$

   (12) + (14) implies

$$C_{jt} = \frac{e_{jt}}{e_t^*} \bar{C}_t, \qquad \forall e_{jt} < e_t^* \tag{15}$$

# Lemma 1

- Average MU:

$$\begin{aligned}\Lambda_t &\equiv \int_0^1 \Lambda_{jt} dj = \int_{e_t^*} \frac{1}{\bar{C}_t} dG(e) + \int^{e_t^*} \frac{e_t^*}{e} \frac{1}{\bar{C}_t} dG(e) \\ &= \frac{1}{\bar{C}_t}[1 - G(e_t^*) + \int_{e_{min}}^{e_t^*} \frac{e_t^*}{e} dG(e)] \end{aligned} \quad (16)$$

- Relative MU

$$\frac{\Lambda_t}{\Lambda_{jt}^*} \equiv e_t^* F(e_t^*)$$

- Define the (inverse) elasticity of $F()$ w.r.t. $e^*$ as

$$\theta \equiv -\frac{F'(e^*)e^*}{F(e^*)} = \frac{1 - G(e^*)}{1 - G(e^*) + e^* \int_{e_{\min}}^{e^*} \frac{1}{e} dG(e)} \in [0, 1), \quad (17)$$

## Lemma 1

*$\theta \in [0, 1)$ increases with inflation disagreement. $\theta = 0$ if and only if inflation expectation is homogeneous.*

# Lemma 2

- Market clearing condition:

$$Y_t = C_t \equiv \bar{C}_t[1 - G(e_t^*)] + \bar{C}_t \int_{e_{\min}}^{e_t^*} \frac{e}{e_t^*} dG(e)$$

- Relative Consumption:

$$\Phi(e_t^*) \equiv \frac{C_t}{\bar{C}_t} \equiv \left[ 1 - G(e_t^*) + \frac{\int_{e_{\min}}^{e_t^*} edG(e)}{e_t^*} \right]. \qquad (18)$$

- Define the (inverse) elasticity of $\Phi()$ to $e^*$ as

$$\mu \equiv -\frac{\Phi'(e^*)e^*}{\Phi(e^*)} = \frac{\int_{e_{\min}}^{e^*} edG(e)}{[1 - G(e^*)]e^* + \int_{e_{\min}}^{e^*} edG(e)} \in (0, 1]. \qquad (19)$$

## Lemma 2

*$\mu \in (0, 1]$ decreases with inflation disagreement. $\mu = 1$ if and only if inflation expectation is homogeneous.*

# Equilibrium

1. Labor market clearing condition:

$$\Lambda_t W_t = \psi N_t^{\gamma}, \qquad \text{where} \quad \Lambda_t = \frac{1}{C_t + \bar{B}} e_t^* F(e_t^*),$$

which implies

$$\hat{W}_t = \frac{\mu + \kappa(1-\theta)}{(1+\kappa)\,\mu} \hat{C}_t + \gamma \hat{N}_t. \tag{20}$$

2. Aggregate output function and good market clearing condition:

$$\hat{C}_t = \hat{N}_t + \hat{Z}_t \tag{21}$$

3. Producer's optimal pricing condition: (Phillips curve)

$$\hat{\pi}_t = \varphi_y [\hat{W}_t - \hat{Z}_t] + \beta \mathbb{E}_t \hat{\pi}_{t+1}. \tag{22}$$

4. Monetary policy rule (3) implies

$$\hat{r}_{ft} = \varphi \hat{\pi}_t + \xi_t \tag{23}$$

# Proposition: discounted Euler equation

$$\hat{C}_t = \underbrace{\frac{\mu + (1-\theta)\kappa}{\mu+\kappa}}_{\equiv\beta_1} \mathbb{E}_t \hat{C}_{t+1} - \underbrace{\frac{(1+\kappa)\mu}{\mu+\kappa}}_{\equiv\beta_2} \left(\hat{r}_{ft} - \mathbf{E}_t \hat{\pi}_{t+1}\right), \quad \kappa \equiv \bar{B}/A \tag{24}$$

## Proposition 3

*The effect of future interest rates change on current consumption is discounted by a factor less than one, e.g.* $\beta_1 < 1$.

## Proposition 4

*Effectiveness of forward guidance on current consumption decreases with dispersion of inflation expectation.* ($\theta \uparrow \rightarrow \beta_1 \downarrow$, $\mu \downarrow \rightarrow \beta_1 \downarrow$)

## Proposition 5

*Effectiveness of current rate change on consumption decreases with dispersion in inflation expectation* ($\mu \downarrow \rightarrow \beta_2 \downarrow$)

# Proposition: stablizing inflation

## Proposition 6

*The effectiveness of contemporaneous monetary surprise on inflation decreases with inflation disagreement.*

## Proof.

$$\hat{\pi}_t = \varphi_y \left\{\beta_3[\beta_1 E_t \hat{C}_{t+1} - \beta_2(\varphi\hat{\pi}_t + \xi_t - \beta E_t \hat{\pi}_{t+1})]\right\} + \beta E_t \hat{\pi}_{t+1}$$

where $\beta_3 \equiv \gamma + \frac{\mu+\kappa(1-\theta)}{(1+\kappa)\mu}$. Thus, we can write

$$\hat{\pi}_t = -\frac{\varphi_y \beta_3 \beta_2}{(1+\varphi_y \beta_3 \beta_2 \varphi)}\xi_t + \frac{\varphi_y \beta_3 \beta_1}{(1+\varphi_y \beta_3 \beta_2 \varphi)} E_t \hat{C}_{t+1} + ... \qquad (25)$$

It's sufficient to prove that $\beta_3\beta_2$ decreases with inflation disagreement:

$$\beta_3\beta_2 = \gamma\beta_2 + \frac{\mu+\kappa(1-\theta)}{\mu+\kappa} = \gamma\beta_2 + 1 - \frac{\kappa\theta}{\mu+\kappa}$$

# Supporting Evidence

# Supporting model mechanism (1)

1. Positive relations between individual inflation expectations and current consumption spending.

- D'Acunto et al. (2021): the announcement of value-added tax increases $\rightarrow$ consumers' inflation expectations $\uparrow$ $\rightarrow$ consumers' inflation expectations $\uparrow$ immediate increase in consumers' readiness to buy durable goods.
- Crump et al. (2022): inflation expectations $\uparrow$ $\rightarrow$ current consumption $\uparrow$ from NYFed SCE
- Coibion et al. (2022): randomized information treatments $\rightarrow$ inflation expectations $\uparrow$ $\rightarrow$ non-durable consumption $\uparrow$
- Vellekoop and Wiederholt (2019): inflation expectations $\uparrow$ $\rightarrow$ durable consumption $\uparrow$ from Dutch Household Survey data

# Supporting model mechanism (2)

"The ability of monetary policy to boost real economic activity hinges on the debt capacity of high marginal propensity to consume households."
— Sufi (2015)

2. Negative relation between household indebtedness and the effectiveness of monetary policy.

- Sufi (2015): limited credit extension channel of monetary policy
- Alpanda and Zubairy (2019): state with $\uparrow$ household debt $\rightarrow$ effects of monetary policy shocks on real activity $\downarrow$
- Beraja et al. (2019); Cloyne et al. (2020): inability of heavily indebted households to refinance mortgages has depressed spending following monetary stimulus during the Great Recession

# Supporting model prediction

$$\hat{C}_t = \underbrace{\frac{\mu + (1-\theta)\kappa}{\mu + \kappa}}_{\equiv \beta_1} \mathbb{E}_t \hat{C}_{t+1} - \underbrace{\frac{(1+\kappa)\mu}{\mu + \kappa}}_{\equiv \beta_2} \left( \hat{r}_{ft} - \mathbf{E}_t \hat{\pi}_{t+1} \right) \quad (26)$$

We use local projection to show

1. ($\beta_1$) effectiveness of forward guidance shock on current economic activity /inflation decreases with inflation disagreement.
2. ($\beta_2$) effectiveness of federal rate shock on current economic activity /inflation decreases with inflation disagreement.

# Transmission of forward guidance shock

We estimate:

$$
\begin{aligned}
& \log(y^j_{t+h}) - \log(y^j_{t-1}) \\
= \quad & \alpha^h_0 + \sum_{i=0,1,2,3} \alpha^h_{1,i} FG_{t-i} + \sum_{i=1,2,3} \alpha^h_{i,2} IQR^{\pi}_{t-i} + \alpha^h_3 IQR^{\pi}_{t-1} * FG_t \\
+ \quad & \sum_{j=1,2,3} \sum_{i=1,2,3} \alpha^h_{4,i} \Delta \log(y^j_{t-i}) + \sum_{i=0,1,2,3} \alpha^h_{5,i} SFFR_{t-i} + \varepsilon_{t+h} \quad (27)
\end{aligned}
$$

- $\log(y^j_{t+h}) - \log(y^j_{t-1})$: cumulative unemployment, IP or inflation growth from period t-1 to period t+h.
- $FG_t$: forward guidance shocks identified following Swanson(2021).
- $IQR_{t-i}$: demeaned interquartile range (IQR) of inflation forecast
- $SFFR_t$ denotes shadow federal funds rate.
- $PCE_{t-i}$: YoY core inflation rates.
- $\varepsilon_{t+h}$: error term.

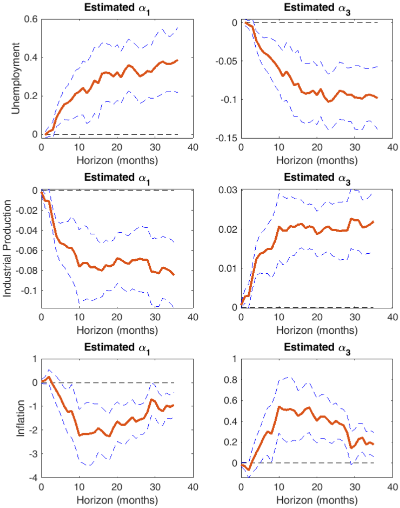


Figure: Impulse responses to forward guidance shocks

# Robustness

TABLE 1. Impulse responses to forward guidance shocks

| $h=12$ | Industrial Production | | | | | Inflation | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| $FG_t$ | -0.072 | -0.110 | -0.106 | -0.073 | -0.107 | -1.921 | -3.000 | -2.496 | -2.182 | -2.930 |
| | (0.036) | (0.060) | (0.052) | (0.038) | (0.052) | (1.161) | (1.481) | (1.226) | (1.205) | (1.226) |
| $IQR^{\pi}_{t-1}$ | 0.002 | 0.002 | 0.004 | 0.002 | 0.004 | 0.409 | 0.348 | 0.378 | 0.431 | 0.443 |
| | (0.005) | (0.005) | (0.004) | (0.005) | (0.004) | (0.253) | (0.261) | (0.179) | (0.247) | (0.196) |
| $IQR^{\pi}_{t-1} * FG_t$ | 0.020 | 0.033 | 0.020 | 0.020 | 0.020 | 0.483 | 0.859 | 0.474 | 0.526 | 0.486 |
| | (0.008) | (0.017) | (0.008) | (0.008) | (0.008) | (0.282) | (0.423) | (0.247) | (0.276) | (0.247) |
| $EX^{\pi}_{t-1}$ | | -0.000 | | | | | 0.044 | | | |
| | | (0.001) | | | | | (0.041) | | | |
| $EX^{\pi}_{t-1} * FG_t$ | | -0.004 | | | | | -0.121 | | | |
| | | (0.004) | | | | | (0.084) | | | |
| $UNC^{c}_{t-1}$ | | | 0.001 | | | | | -0.262 | | |
| | | | (0.008) | | | | | (0.191) | | |
| $UNC^{c}_{t-1} * FG_t$ | | | 0.010 | | | | | 0.167 | | |
| | | | (0.008) | | | | | (0.196) | | |
| $UNC^{b}_{t-1}$ | | | | -0.001 | | | | | -0.010 | |
| | | | | (0.002) | | | | | (0.053) | |
| $UNC^{b}_{t-1} * FG_t$ | | | | 0.000 | | | | | 0.022 | |
| | | | | (0.001) | | | | | (0.034) | |
| $IQR^{gdp}_{t-1}$ | | | | | 0.001 | | | | | -0.006 |
| | | | | | (0.008) | | | | | (0.200) |
| $IQR^{gdp}_{t-1} * FG_t$ | | | | | 0.010 | | | | | 0.291 |
| | | | | | (0.008) | | | | | (0.199) |

# Transmission of federal fund rate shock

We estimate:

$$
\begin{aligned}
& \log(y^j_{t+h}) - \log(y^j_{t-1}) \\
= \quad & \beta^h_0 + \sum_{i=0,1,2,3} \alpha^h_{1,i} MP_{t-i} + \sum_{i=1,2,3} \alpha^h_{i,2} IQR^{\pi}_{t-i} + \alpha^h_3 IQR^{\pi}_{t-1} * MP_t \\
+ \quad & \sum_{j=1,2,3} \sum_{i=1,2,3} \alpha^h_{4,i} \Delta \log(y^j_{t-i}) + \sum_{i=0,1,2,3} \alpha^h_{5,i} SFFR_{t-i} + \varepsilon_{t+h} \quad (28)
\end{aligned}
$$

- $MP^{orth}_t$: target shocks identified following Swanson (2021).

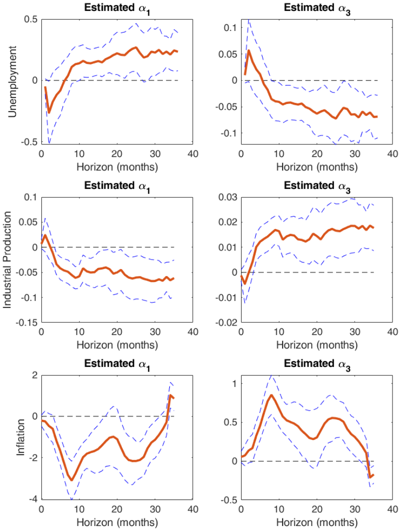


Figure: Impulse responses to federal fund rate shocks

# Robustness

TABLE 2. Impulse responses to federal fund rate shocks

| $h = 12$ | Industrial Production | | | | | Inflation | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| $MP_t$ | -0.048 | -0.063 | -0.074 | -0.046 | -0.074 | -1.809 | -2.659 | -1.338 | -1.957 | -2.734 |
| | (0.027) | (0.030) | (0.027) | (0.028) | (0.027) | (0.706) | (0.811) | (0.946) | (0.766) | (0.782) |
| $IQR^{\pi}_{t-1}$ | 0.002 | 0.001 | 0.002 | 0.002 | 0.002 | 0.439 | 0.376 | 0.430 | 0.466 | 0.473 |
| | (0.006) | (0.006) | (0.004) | (0.006) | (0.004) | (0.231) | (0.249) | (0.191) | (0.233) | (0.179) |
| $IQR^{\pi}_{t-1} * MP_t$ | 0.014 | 0.021 | 0.013 | 0.014 | 0.013 | 0.527 | 0.877 | 0.230 | 0.567 | 0.528 |
| | (0.007) | (0.009) | (0.007) | (0.007) | (0.007) | (0.203) | (0.286) | (0.193) | (0.189) | (0.153) |
| $EX^{\pi}_{t-1}$ | | -0.000 | | | | | 0.073 | | | |
| | | (0.001) | | | | | (0.043) | | | |
| $EX^{\pi}_{t-1} * MP_t$ | | -0.004 | | | | | -0.138 | | | |
| | | (0.004) | | | | | (0.080) | | | |
| $UNC^{c}_{t-1}$ | | | 0.001 | | | | | 00.247 | | |
| | | | (0.001) | | | | | (0.186) | | |
| $UNC^{c}_{t-1} * MP_t$ | | | -0.003 | | | | | 0.163 | | |
| | | | (0.003) | | | | | (0.143) | | |
| $UNC^{b}_{t-1}$ | | | | -0.001 | | | | | -0.009 | |
| | | | | (0.001) | | | | | (0.050) | |
| $UNC^{b}_{t-1} * MP_t$ | | | | 0.000 | | | | | 0.002 | |
| | | | | (0.002) | | | | | (0.061) | |
| $IQR^{gdp}_{t-1}$ | | | | | 0.004 | | | | | 0.027 |
| | | | | | (0.008) | | | | | (0.213) |
| $IQR^{gdp}_{t-1} * MP_t$ | | | | | 0.008 | | | | | 0.264 |
| | | | | | (0.008) | | | | | (0.126) |

# Conclusion

High inflation disagreements weaken the potency of monetary policy, both types.

# Appendix

# Robustness: transmission of forward guidance shock

Controlling for $X$:

$$
\begin{aligned}
& \log(y^j_{t+h}) - \log(y^j_{t-1}) \\
= \quad & \alpha^h_0 + \sum_{i=0,1,2,3} \alpha^h_{1,i} FG_{t-i} + \sum_{i=1,2,3} \alpha^h_{i,2} IQR^{\pi}_{t-i} + \alpha^h_3 IQR^{\pi}_{t-1} * FG_t \\
+ \quad & \sum_{j=1,2,3} \sum_{i=1,2,3} \alpha^h_{4,i} \Delta \log(y^j_{t-i}) + \sum_{i=0,1,2,3} \alpha^h_{5,i} SFFR_{t-i} \\
+ \quad & \sum_{i=1,2,3} \alpha^h_{i,7} X_{t-i} + \alpha^h_8 X_{t-1} * FG_t + \varepsilon_{t+h}
\end{aligned}
\tag{29}
$$

X includes: inflation expectation, consumer uncertainty, business uncertainty, disagreements of GDP and interest rate paths etc.

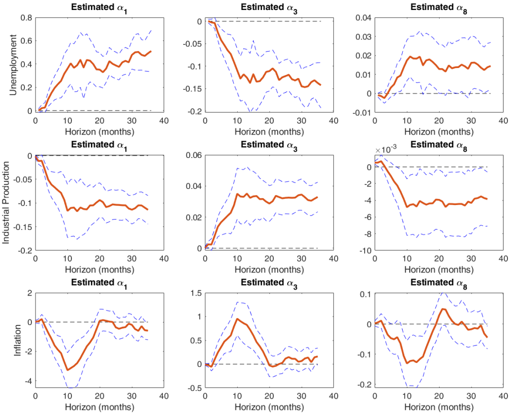


Figure: Estimated response to forward guidance shocks (controlling for consumer uncertainty)

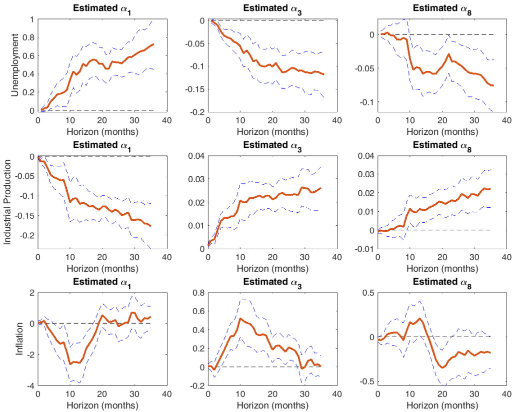


Figure: Estimated response to forward guidance shocks (controlling for inflation expectation)

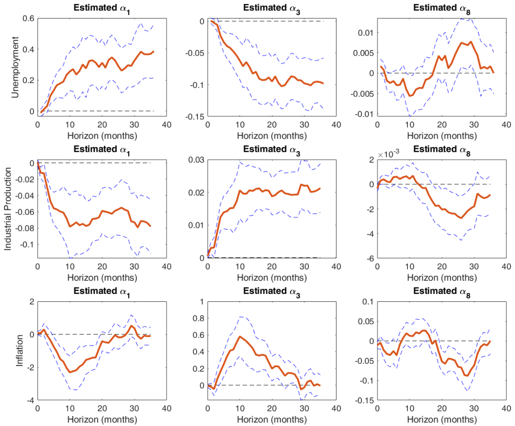


Figure: Estimated response to forward guidance shocks (controlling for business uncertainty)

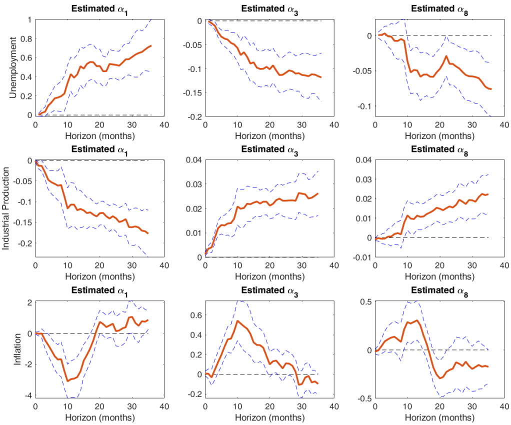


Figure: Estimated response to forward guidance shocks (controlling for forecast dispersion of GDP)

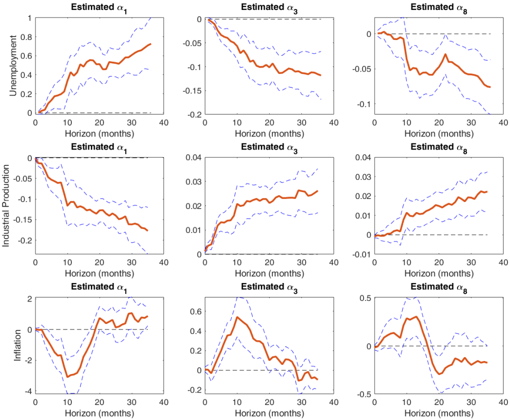


Figure: Estimated response to forward guidance shocks (controlling for forecast dispersion of federal funds rate)

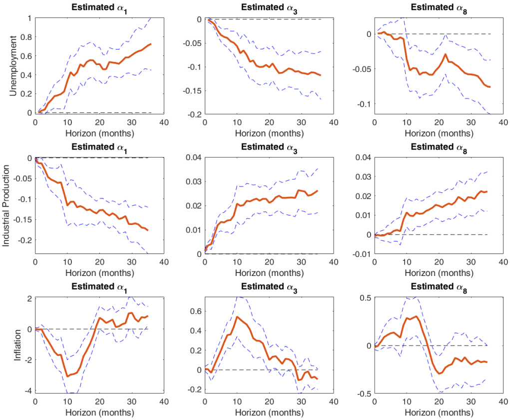


Figure: Estimated response to forward guidance shocks (controlling for forecast disagreement of 2-year Treasury yield)

# Robustness: transmission of federal fund rate shock

Controlling for $X$:

$$\begin{aligned} & \log(y^j_{t+h}) - \log(y^j_{t-1}) \\ = \quad & \alpha^h_0 + \sum_{i=0,1,2,3} \alpha^h_{1,i} MP_{t-i} + \sum_{i=1,2,3} \alpha^h_{i,2} IQR^{\pi}_{t-i} + \alpha^h_3 IQR^{\pi}_{t-1} * MP_t \\ + \quad & \sum_{j=1,2,3} \sum_{i=1,2,3} \alpha^h_{4,i} \Delta \log(y^j_{t-i}) + \sum_{i=0,1,2,3} \alpha^h_{5,i} SFFR_{t-i} \\ + \quad & \sum_{i=1,2,3} \alpha^h_{i,7} X_{t-i} + \alpha^h_8 X_{t-1} * MP_t + \varepsilon_{t+h} \end{aligned} \tag{30}$$

X includes: inflation expectation, consumer uncertainty, business uncertainty, disagreements of GDP and interest rate paths etc.

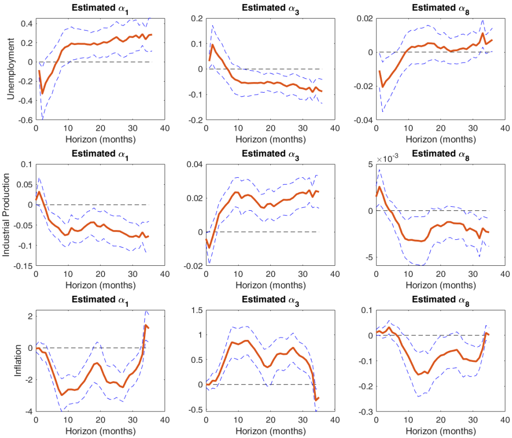


Figure: Estimated response to federal fund rate shocks (controlling for consumer uncertainty)

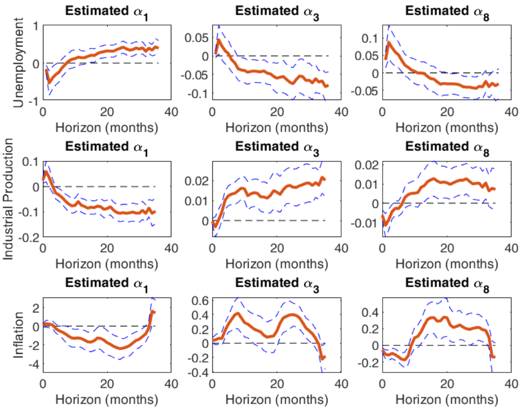


Figure: Estimated response to federal fund rate shocks (controlling for inflation expectation)

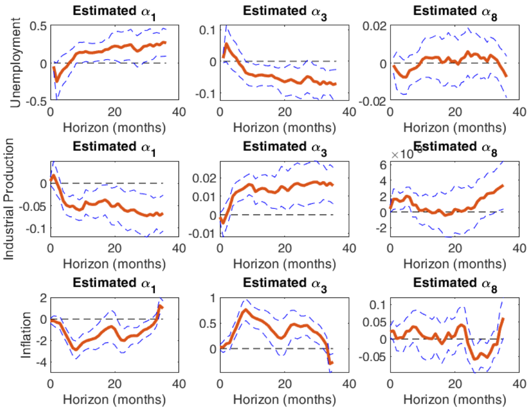


Figure: Estimated response to federal fund rate shocks (controlling for business uncertainty)

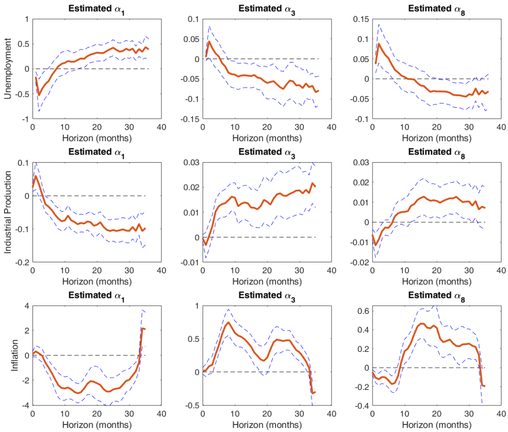


Figure: Estimated response to federal fund rate shocks (controlling for forecast dispersion of GDP)

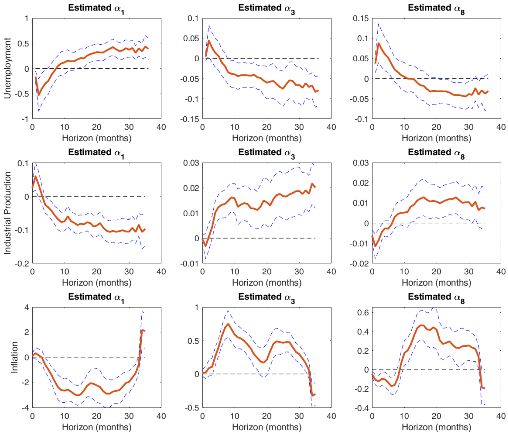


Figure: Estimated response to federal fund rate shocks (controlling for forecast dispersion of federal funds rate)

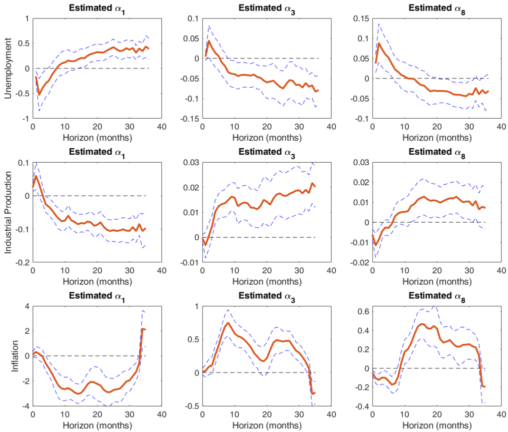


Figure: Estimated response to federal fund rate shocks (controlling for forecast disagreement of 2-year Treasury yield)