Sticky Inflation: Monetary Policy when Deficits Drag Inflation Expectations

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Introduction

Large fiscal shocks often lead to rising national debt and **surges in inflation**

- See Hall & Sargent, 2021, 2022

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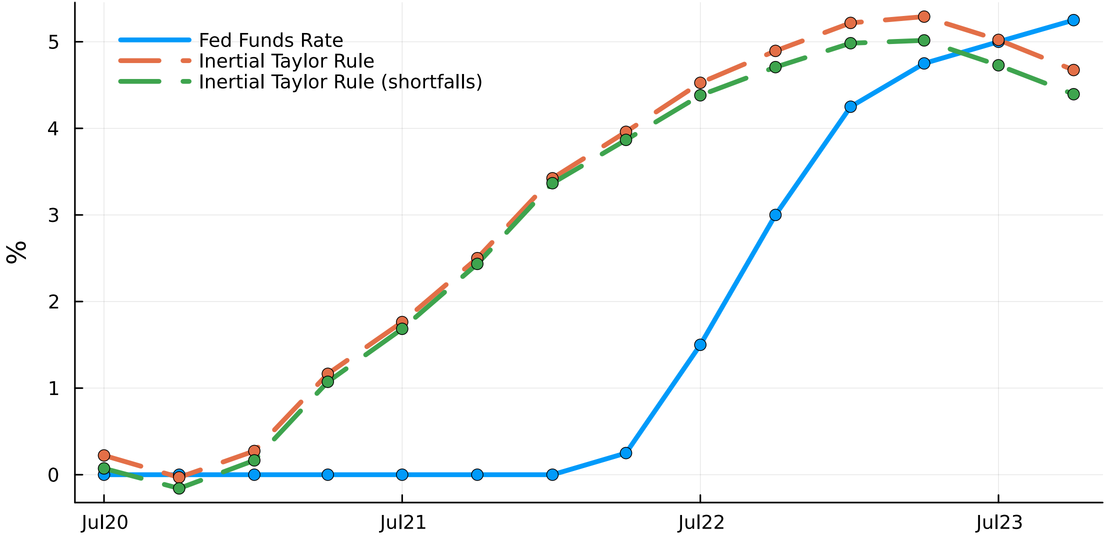
- rate hikes can **increase public debt**
- may trigger an increase in **inflation expectation** to stabilize debt

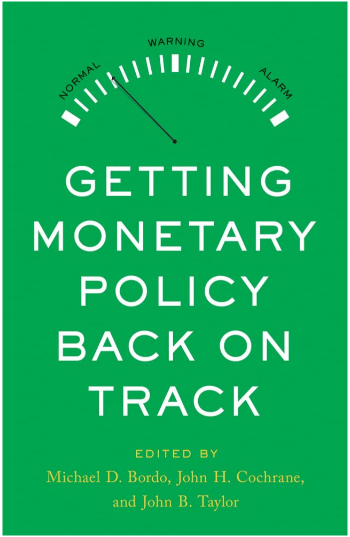
How should monetary policy respond in this scenario?

Fed Funds rate vs Taylor rule



Note: Taylor rules follow the specification in Papell and Prodan (2022).

Was the Fed behind the curve?



"They (policymakers and academics) met at a tumultuous time: the previous year, inflation had surged, and some believed the Federal Reserve was slow to react.
(...) Participants considered whether the sluggish response made the situation worse, and how to get inflation back under control."

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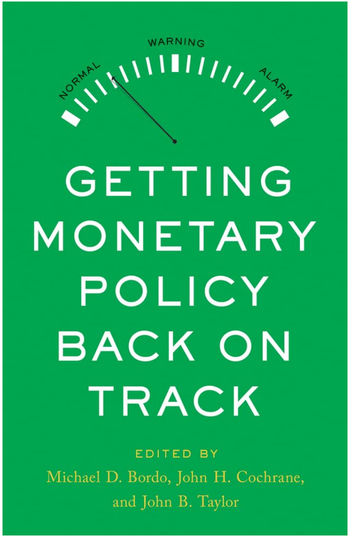

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This paper:

- Monetary model with fiscal shocks
  - Expectations of change in policy stance
- Optimal monetary policy
  - CB should be slow to react!

Main contributions

1. Characterize analytically the phenomenon of **sticky inflation**
   - Anticipation of an **inflationary-financing** event drags inflation expectations
   - Sticky inflation shows up as an **endogenous fiscal cost-push shock**

2. Solve for the optimal policy
   - It is optimal to **underreact** to the fiscal shock
   - Real rates go down in response to the fiscal shock

3. Produce policy-counterfactuals for the post-pandemic U.S. inflation
   - Fiscal shocks explain a significant part of the inflation surge
   - Following Taylor principle would have led to higher inflation and debt levels

Model

Government

Fiscal authority

- Flow budget constraint:

$$\dot{B}_t = (i_t - \pi_t)B_t + T_t,$$

where B_t is real debt.

- Fiscal rule:

$$T_t = \overline{T} - (\rho + \gamma)(B_t - \overline{B}) + \Psi_t ,$$

where $\gamma \geq 0$.

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- Active money/passive fiscal (Leeper, 1991)

Fiscal adjustment

Economy starts in the **fiscal-expansion phase**

- Economy is hit by a fiscal shock $\Psi_t > 0$

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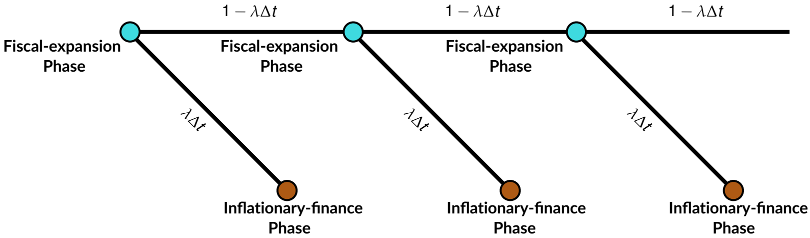
With Poisson intensity λ, economy goes to the **inflationary-finance phase**

- Fiscal adjustment is partially done by *monetary accommodation*
- Real rates are kept low until debt reaches sustainable level B^n



Euler equation

Euler equation: (with log utility)

$$\dot{x}_t = i_t - \pi_t - \rho - \underbrace{\lambda_h (x_t^J - x_t)}_{\text{policy uncertainty}}$$

where $x_t \equiv \dfrac{Y_t - Y}{Y}$ and x_t^J is output gap in inflationary-finance phase.

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Solving it forward:

$$x_t = \underbrace{-\int_t^\infty e^{-\lambda_h (s-t)} (i_s - \pi_s - \rho) ds}_{\text{intertemporal-substitution effect}} + \underbrace{\lambda_h \int_t^\infty e^{-\lambda_h (s-t)} x_s^J ds}_{\text{policy-expectation effect}},$$

Note: Subjective arrival rate λ_h may differ from objective one λ.

Phillips curve

NK Phillips curve:

$$\dot{\pi}_t = (\rho + \lambda_f)\pi_t - \kappa x_t - \lambda_f \pi_t^J,$$

where π_t^J is inflation in inflationary-finance phase.

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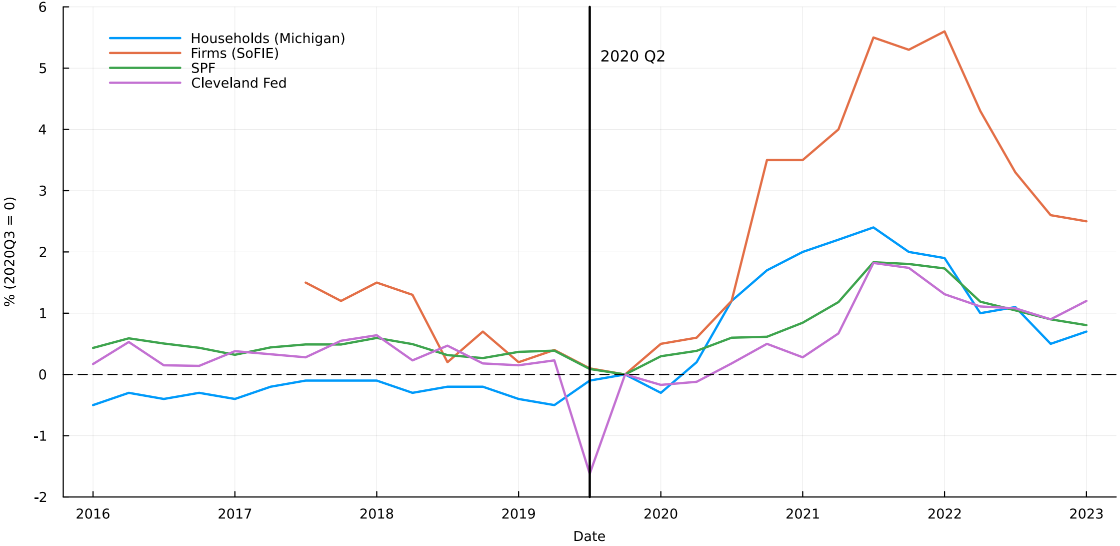
Solving it forward:

$$\pi_t = \underbrace{\kappa \int_t^\infty e^{-(\rho+\lambda_f)(s-t)} x_s ds}_{\text{output-gap effect}} + \underbrace{\lambda_f \int_t^\infty e^{-(\rho+\lambda_f)(s-t)} \pi_s^J ds}_{\text{policy-expectation effect}}$$

Firm's subjective expectations may differ from households' expectations

- Consistent with evidence (see Candia, Coibion and Gorodnichenko (2023))

Stronger reaction of firms' expectations



Inflationary-finance phase

In the inflationary-finance, monetary authority keeps rates low for T^* periods

- Real interest rate must satisfy

$$r^* = \rho - \frac{b_0^* - b^n}{T^*},$$

where $b^n \equiv \dfrac{B^n - \overline{B}}{\overline{B}}$.

Output gap and inflation:

$$x^J(b_t) = b_t - b^n, \qquad \pi^J(b_t) = \kappa\, \Phi\, (b_t - b^n)\ .$$

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Output gap and inflation:

debt pass-through

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A 4-equation representation

$$
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i_t &= \rho + \phi \pi_t + u_t && \text{(Taylor rule)} \\
\dot{x}_t &= i_t - \pi_t - \rho + \lambda_h x_t - \lambda_h (b_t - b^n) && \text{(Euler eq.)} \\
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Role of λ_f v.s. λ_h: Suppose $\lambda_f = 0$ and $\gamma > \lambda_h$. Set

$$
i_t - \pi_t = \rho + \lambda_h(b_t - b^n).
$$

Then, $x_t = \pi_t = 0 \Rightarrow$ divine coincidence holds.

Three Policy Experiments

Experiment I: output-gap stabilization

Suppose $\gamma = \lambda_h = 0$.

The central bank stabilizes the output gap:

$$\dot{x}_t = 0 \Rightarrow r_t - \rho = 0.$$

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Government debt in initial phase:

$$\dot{b}_t = r_t - \rho + \psi_t \implies \dot{b}_t = \psi_t.$$

Government debt and inflation increase over time: (for $\psi_t = e^{-\theta_\psi t}\psi_0$)

$$b_t = b_0 + \frac{1 - e^{-\theta_\psi t}}{\theta_\psi}\psi_0, \qquad \pi_t = \frac{\kappa\lambda\Phi}{\rho + \lambda}\left[b_t - b^n + \frac{\psi_t}{\rho + \lambda + \theta_\psi}\right].$$

Experiment II: inflation stabilization

In the previous example, the real rate was constant

- Now, to fight inflation, the central bank raises real rates: $r_t - \rho = e^{-\theta_r t}(r_0 - \rho)$.
- Higher rates depress output.

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Proposition (Successful fight condition)

Suppose $r_0 > \rho$. The policy reduces inflation at time zero if and only if:

$$\theta_r < \frac{\rho + \lambda}{\lambda \Phi}.$$

Stepping on a rake

What happens as we move away from $t = 0$?

- Fight-inflation term goes to zero
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Proposition (Stepping on a Rake)

There exists $\hat{T}$ such that $\pi_t > \pi_t^{og}$ for $t > \hat{T}$.

Term coined by Chris Sims

- Same result under very different conditions
- Long-term nominal bonds and $\phi < 1$

Experiment III: debt stabilization

Suppose next the monetary authority stabilizes **government debt**

- This requires $r_t - \rho = -\psi_t$, so $b_t = b_0$.
- Low rates lead to positive output gap and inflation

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Conclusion: It is impossible to simultaneously stabilize output gap and inflation

- **Divine coincidence** fails in this economy
- Even though there are no supply shocks

Expectation effects create an endogenous **fiscal cost-push shock**

$$\dot{\pi}_t = (\rho + \lambda)\pi_t - \kappa x_t - \underbrace{\kappa \lambda \Phi(b_t - b^n)}_{\text{fiscal cost-push shock}}$$

Optimal policy

Planner's objective in inflationary-finance phase

Planner minimizes expected squared deviations from steady state

- Planner's objective in inflationary-finance phase:

$$\mathcal{P}^{II}(b_0^*) = \int_0^{T^*} e^{-\rho t}(\alpha x_t^{*2} + \beta \pi_t^{*2})dt.$$

The planner's objective is determined by initial debt

- Effect on inflationary-finance phase is indirect through b_0^*

As (x_t^*, π_t^*) depend on b_0^*, we can write the objective as follows:

$$\mathcal{P}^{II}(b_0^*) = \Upsilon(b_0^* - b^n)^2,$$

where Υ depends on α and β.

Debt-stabilization motive

Planner's objective at the beginning of initial phase:

$$\mathcal{P} = -\frac{1}{2}\mathbb{E}\left[\int_0^\tau e^{-\rho t}\left(\alpha x_t^2 + \beta \pi_t^2\right) dt + e^{-\rho\tau}\mathcal{P}_\tau^{II}(b_\tau)\right],$$

subject to

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and the initial condition for inflation, given b_0 and the path of fiscal shock ψ_t.

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Important:

1. Path of government debt matters
2. Debt acts an endogenous cost-push shock
3. Interest rate does **not** drop from the problem

Incentive to expropriate

Classical solution does not exist: Planner has an incentive to expropriate debt in $t = 0$:

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- Planner can have real rates very negative for a very short-period of time

We focus on the case the planner is not allowed to expropriate

- Implement this by introducing penalty on choice of x_0 and π_0 (previous commitment)
- Analogous to Marcet and Marimon (2019) and Dávila and Schaab (2023)

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Planner's problem:

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Optimal underreaction

Proposition (Real and nominal interest rates.)

The path of real interest rates under the optimal policy is given by

$$r_t - \rho = -\beta \frac{\kappa(1 + \lambda\Phi)}{\lambda \Upsilon + \alpha} \pi_t - \frac{\lambda \Upsilon}{\lambda \Upsilon + \alpha} \psi_t,$$

and the path of nominal rates is

$$i_t - \rho = \left[1 - \beta \frac{\kappa(1 + \lambda\Phi)}{\lambda \Upsilon + \alpha} \right] \pi_t - \frac{\lambda \Upsilon}{\lambda \Upsilon + \alpha} \psi_t.$$

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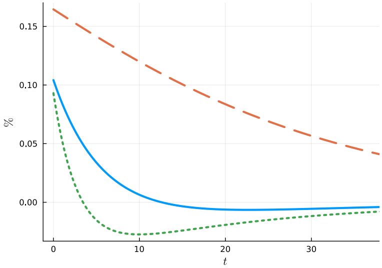
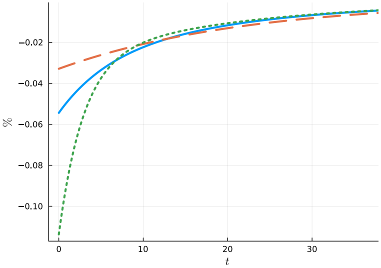
If $\lambda > 0$, planner faces a trade-off

- Benefit of reducing debt is *first order*
- Cost of distorting output gap in Phase I is *second order*

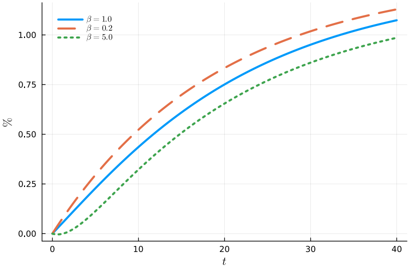
Optimal policy according to Doves and Hawks



(a) Inflation

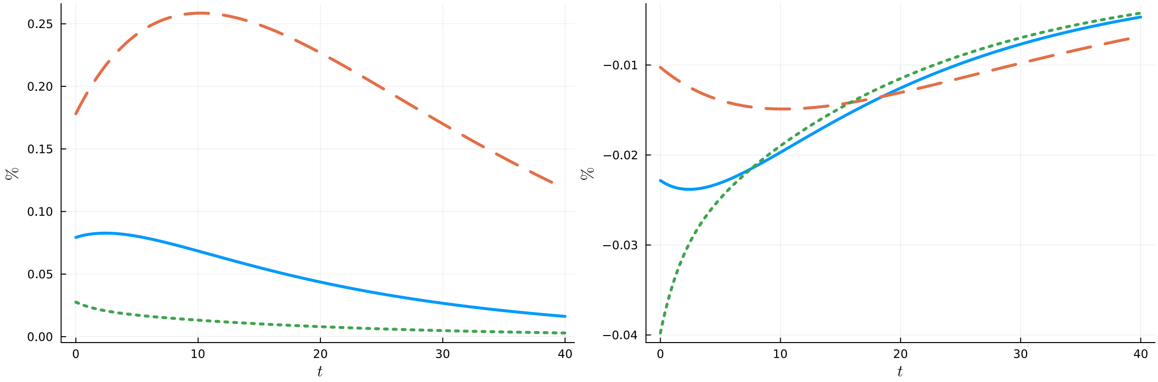


(b) Real rates



(c) Government debt

Optimal policy with imperfect credibility



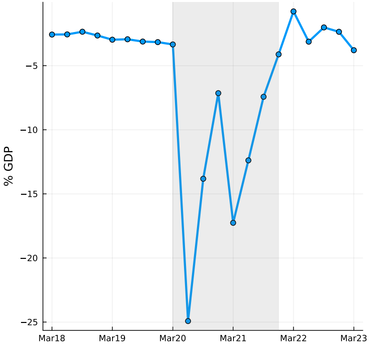
(a) Inflation (b) Real rates

Quantitative exercise

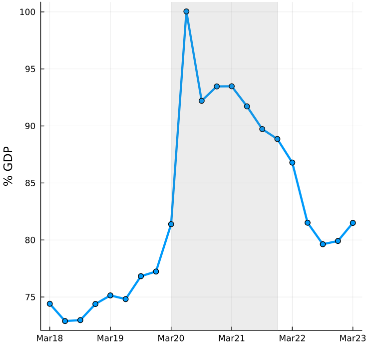
The consequences of a large fiscal shock

US experienced an extremely large fiscal shock in response to the Covid-19 pandemic

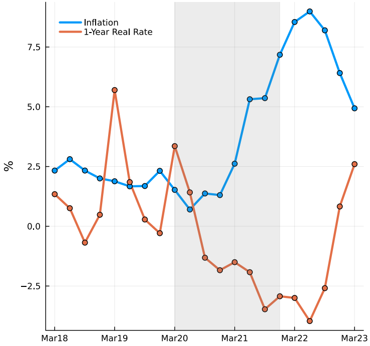
- This led to a large increase in government debt
- Followed by high inflation and low real rates



(a) Primary surplus



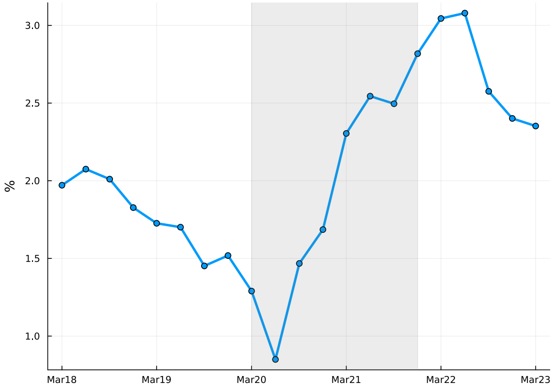
(b) Public Debt/GDP



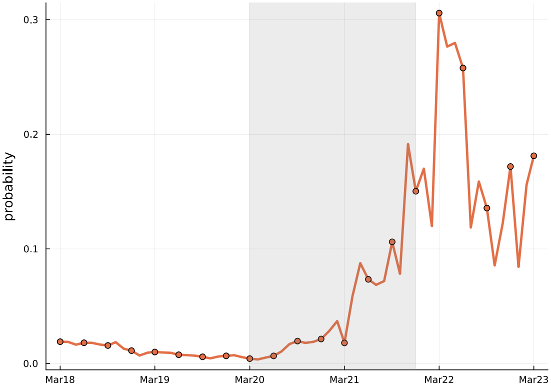
(c) Inflation and real rates

▸ Inflation expectations ▸ Performance gov't bonds ▸ Hall & Sargent decomposition

Inflation expectations and inflation disasters



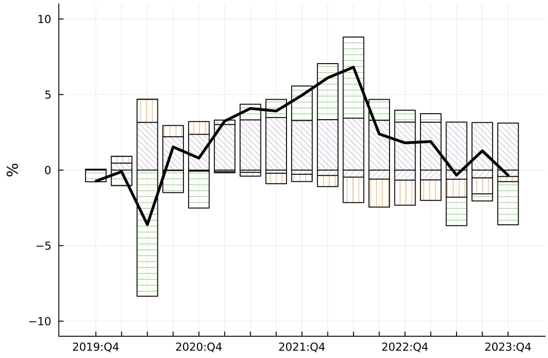
(a) 5-year breakeven inflation



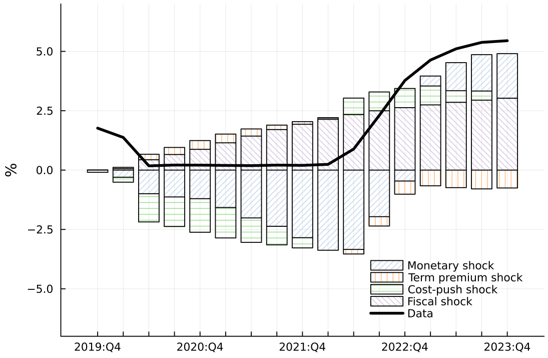
(b) Probability of inflation disaster

Note: Inflation disaster = option-implied probability of inflation $>$ 4% on average in the next five years. Source: Hilscher, Raviv, Reis (2024).

Historical decomposition: Inflation and interest rates

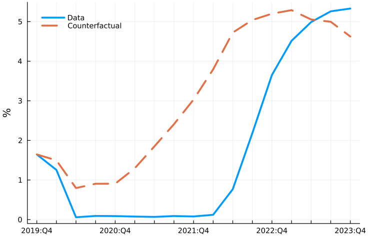


(a) Inflation

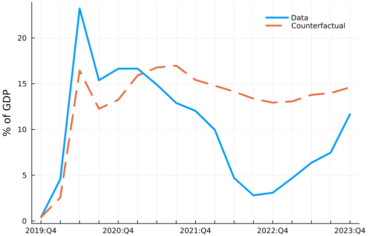


(b) Federal Funds Rate

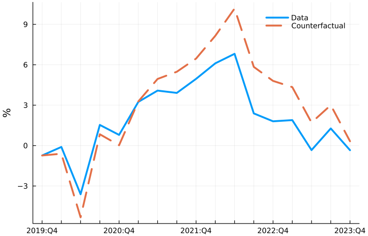
Taylor rule counterfactuals



(a) Federal Funds Rate



(b) Public Debt to GDP



(c) Inflation

Conclusion

How should the monetary authority react to a large fiscal shock?

- Households and firms may expect **monetary accommodation**
- Raising rates may lead to a **"stepping on a rake"** phenomenon

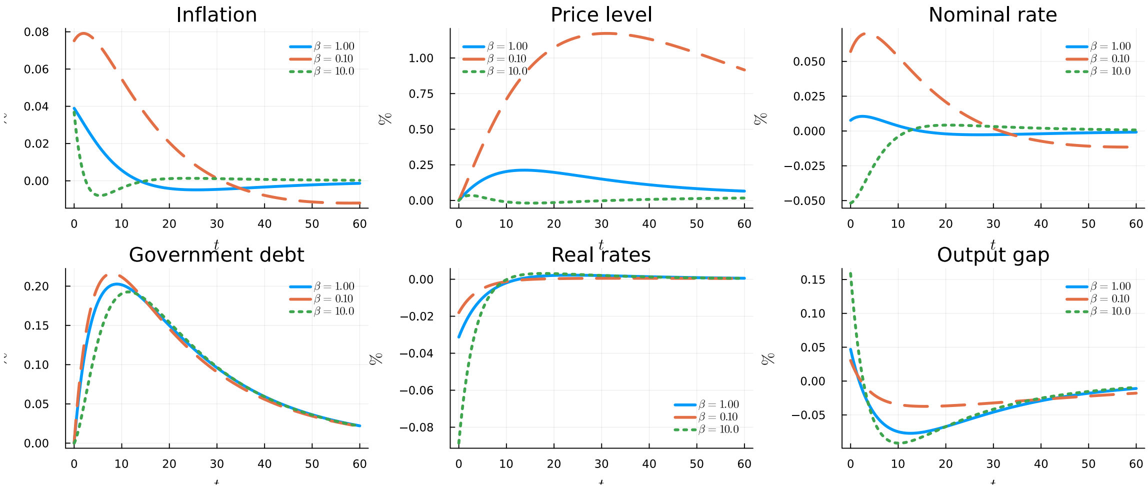
Optimal monetary policy involves **underreaction** to the fiscal shock

- Nominal rates move less than one-to-one with inflation
- **Real rates fall** to accommodate the fiscal shock

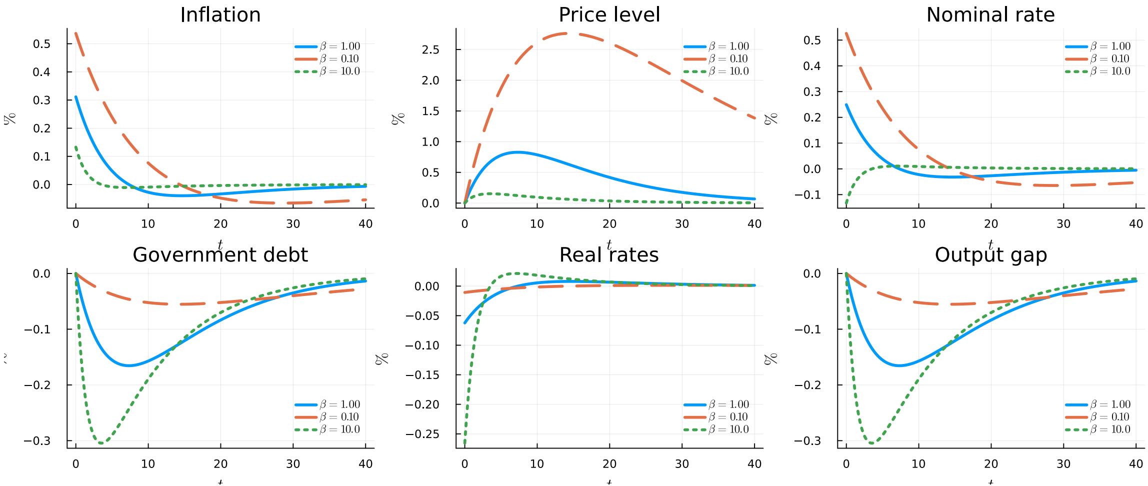
Historical shock decomposition shows that a "Taylor rule" would have **increased** inflation.

- Fed's deviation from Taylor rule reduced the observed inflation.
- Fiscal cost-push shock created **"sticky inflation"**

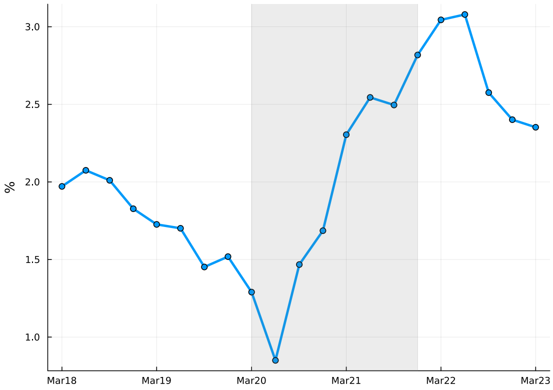
Optimal policy with automatic debt stabilizer ($\gamma > 0$)



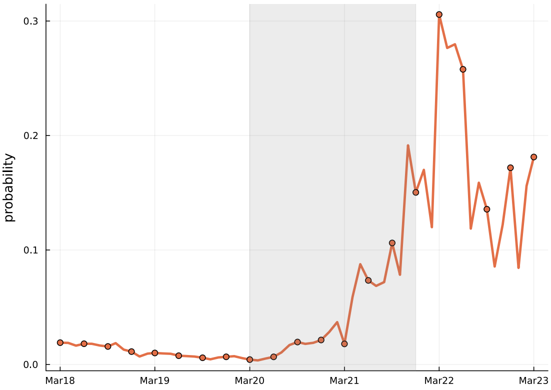
Optimal policy in textbook model



Inflation expectations and inflation disasters



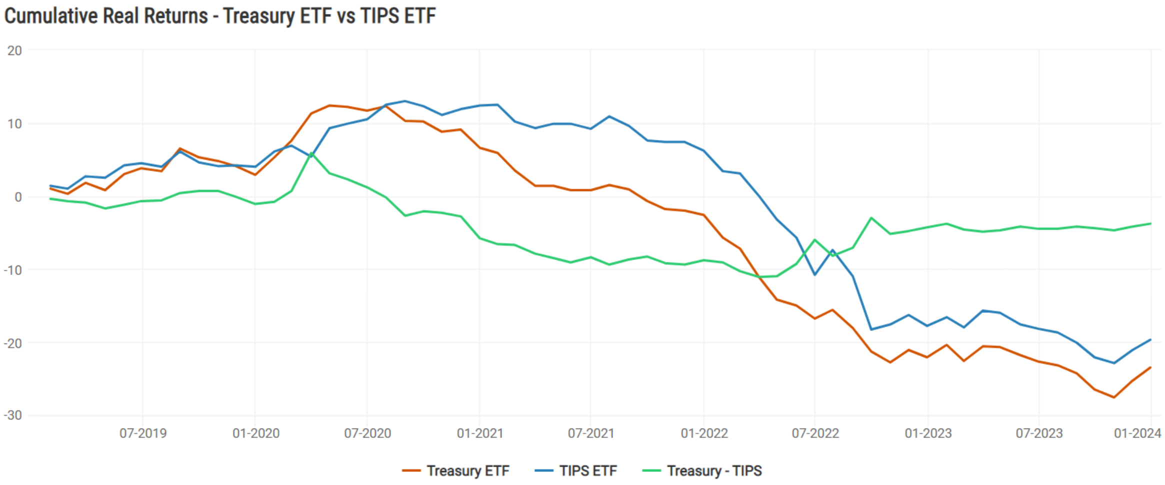
(a) 5-year breakeven inflation



(b) Probability of inflation disaster

Note: Inflation disaster = option-implied probability of inflation $>$ 4% on average in the next five years. Source: Hilscher, Raviv, Reis (2024). back

Real performance of nominal and inflation-protected bonds



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Hall & Sargent decomposition of debt-to-GDP ratio

	Change in QB/Y	Contr. Deficits	Contr. Inflation	Contr. Growth	Contr. Nom. Returns	Contr. Real Returns
1990-Pre-Trump	53.92	25.22	-37.04	-47.80	113.54	76.50
Trump I: 2017-2018	-1.10	3.43	-4.27	-5.29	5.03	0.76
Trump II: 2019-2021	29.09	15.35	-3.81	-5.01	22.56	18.74
Pre-Post COVID: 2020-2022	-0.14	24.67	-17.44	-9.13	1.77	-15.67
Biden: 2021-2023	-20.18	16.30	-18.07	-10.88	-7.52	-25.60

Table: Contribution of Primary Deficits, Inflation, Growth, Nominal Returns, and Real Returns to Changes in Debt-to-GDP

▸ back

Calibration

Parameter	Symbol	Value	Description
Discount rate	ρ	0.0022	Real-rate average (1990-2019)
Elast. of Intertemporal Substitution	σ	0.5	Attanasio and Weber (1995)
Slope of the NKPC	κ	0.0138	Hazell et al. (2022)
Taylor coefficient	ϕ_π	1.2	Moderate response calibration
Fiscal rule	γ	0.038	Bianchi et al. (2023)
Initial debt to quarterly GDP ratio	b^n	0.7683*4	Debt to GDP in 2019Q4
Quart's of high inflation in Phase II	T^*	16	Hazell and Hobler (2024)
Probability of Phase II	λ_f	0.015	Hilscher et al. (2022)