Expectations and the Neutrality of Interest Rates

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Challenge

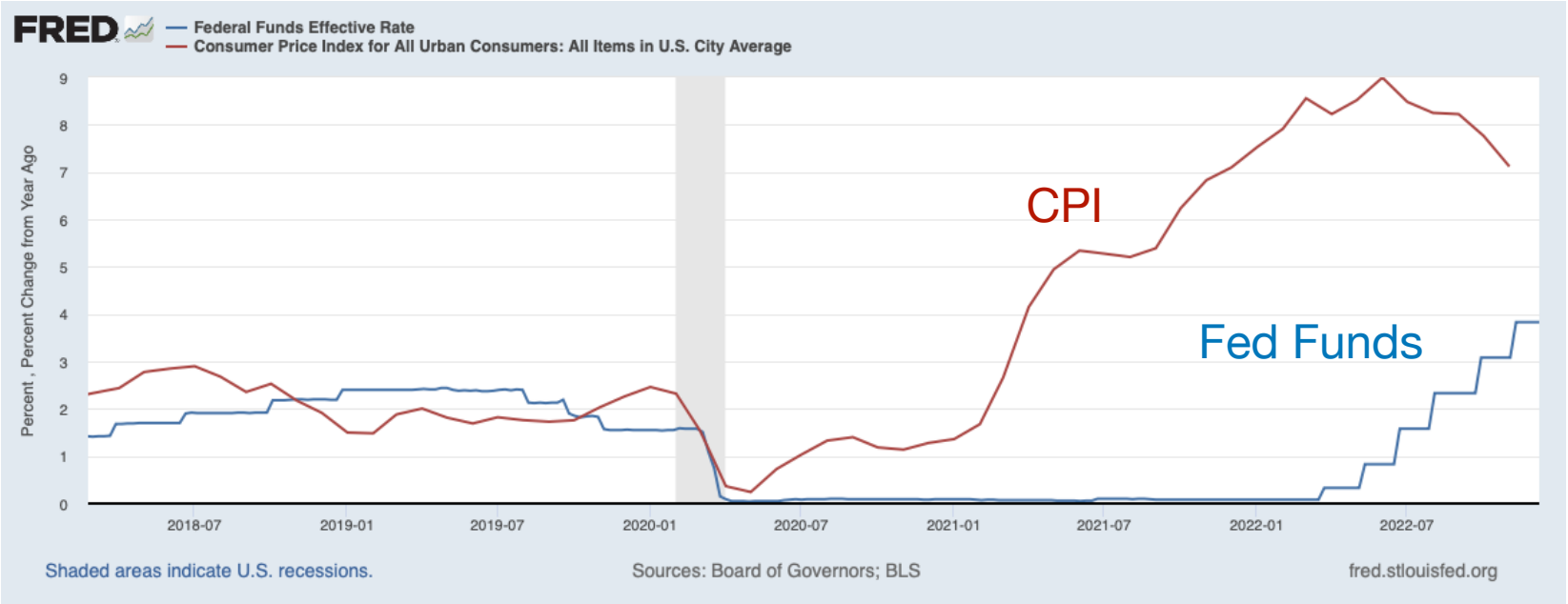
- Lucas (1972): MV=PY; $\pi_t = E_{t-1}\pi_t + \kappa x_t$. Long run neutrality, short-run non-neutrality, rational expectations, proper general equilibrium. Why money, inflation sometimes raise output.
- Challenge: Central banks set interest rates, not money supply. How does inflation respond to interest rate targets?
- Wanted: Lucas-like. Clear economics, long-run neutrality, short-run non-neutrality. The most basic model, not big black box.
- Today: Despite 40 years of work, this is unsettled theory, and no solid empirical understanding.
- In particular:
  - Is inflation stable or unstable under an interest-rate peg?
  - Do higher nominal interest rates, with fiscal policy constant, raise or lower inflation?
  - Under what preconditions, and by what economic mechanism?

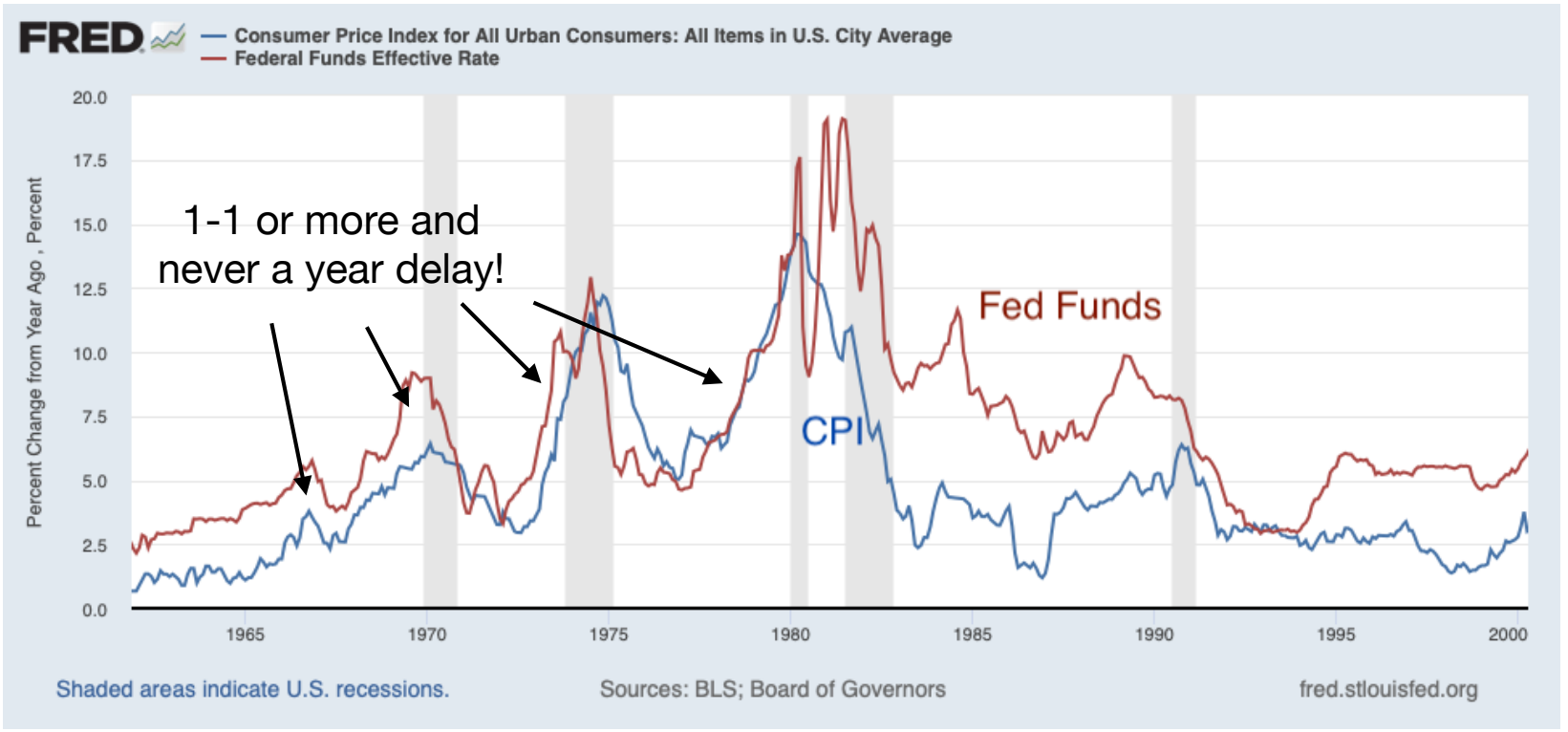
Importance for today's policy

Fed is responding slowly, even by standards of the 1970s.

Does this raise inflation, threatens spiral?

Will inflation subside with interest < inflation? Or must we repeat 1980s? (1975?)





Theory of inflation under interest rate targets (much simplified)

Model $x_t = E_t x_{t+1} - \sigma(i_t - \pi_t^e)$ ⟵ In place of $m_t + v = p_t + x_t$

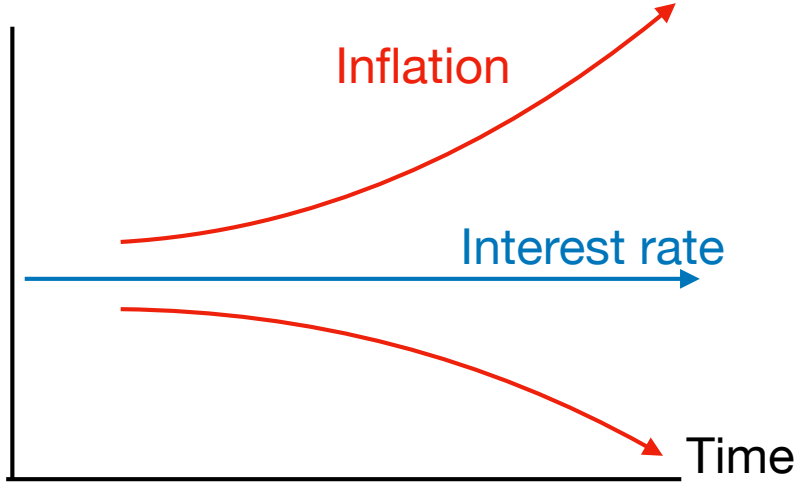
$\pi_t = \pi_t^e + \kappa x_t$

Inflation dynamics $\pi_t = (1 + \sigma\kappa)\pi_t^e - \sigma\kappa i_t$.

History: $\pi_t^e = \pi;\ \pi_{t-1};\ E_{t-1}\pi_t;\ E_t\pi_{t+1}$ (> 1, < 0)

1) Adaptive Expectations $\pi_t^e = \pi_{t-1} \rightarrow \pi_t = (1 + \sigma\kappa)\pi_{t-1} - \sigma\kappa i_t$.

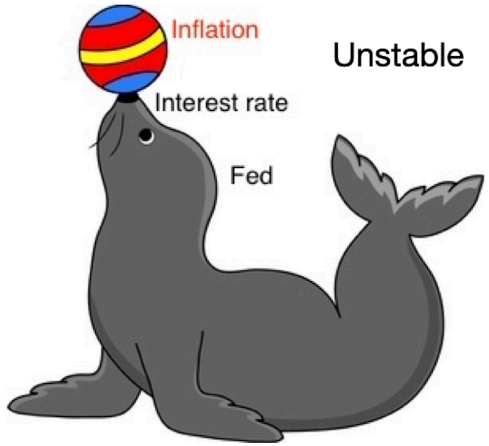
a) Friedman (1968): i peg is *unstable.*



b) Taylor rule + adaptive

$$i_t = \phi\pi_t \rightarrow \pi_t = \frac{1 + \sigma\kappa}{1 + \sigma\kappa\phi}\pi_{t-1}.$$

Fed stabilizes inflation with adaptive E.



But… Are adaptive (model-inconsistent) expectations *necessary* to a theory of inflation with interest rate targets? Always & everywhere? Neutrality?

Theory of inflation under interest rate targets (much simplified)

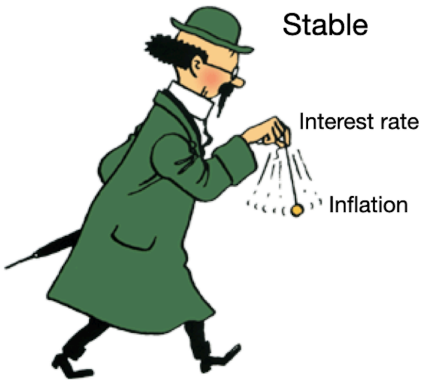
Model $x_t = E_t x_{t+1} - \sigma(i_t - \pi_t^e)$

$\pi_t = \pi_t^e + \kappa x_t$

Inflation dynamics $\pi_t = (1+\sigma\kappa)\pi_t^e - \sigma\kappa i_t\,.$

2) Rational expectations $\pi^e = E_t\pi_{t+1} \;\rightarrow\; E_t\pi_{t+1} = \dfrac{1}{1+\sigma\kappa}\pi_t + \dfrac{\sigma\kappa}{1+\sigma\kappa} i_t$ (<1, >0)

a) Sargent-Wallace (1975): Inflation is *stable*, but *indeterminate.*



b) Fiscal theory of the price level

$$\Delta E_{t+1}\pi_{t+1} = \Delta E_{t+1}\sum_{j=0}^{\infty}\rho^j(-\tilde{s}_{t+1+j} + r_{t+1+j});\; \Delta E_{t+1} \equiv E_{t+1} - E_t$$

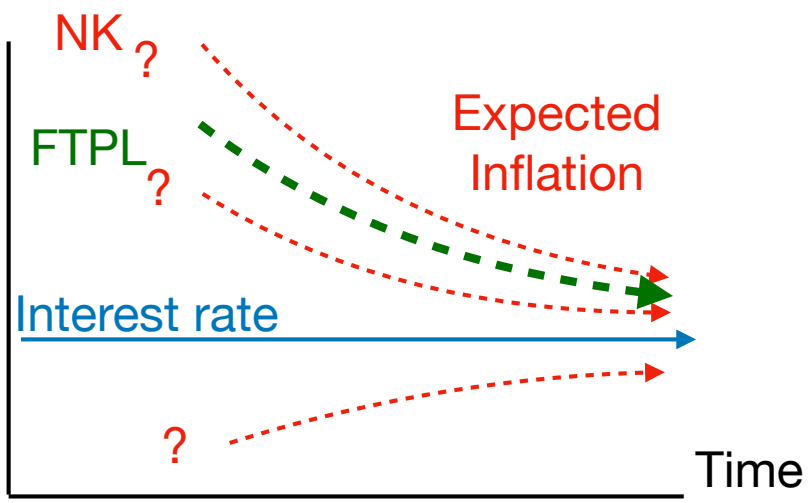
- Inflation is *stable* and *determinate* (at last).
- Frictionless neutral version

$$i_t = E_t\pi_{t+1};\;\; \Delta E_{t+1}\pi_{t+1} = -\,\Delta E_{t+1}\sum_{j=0}^{\infty}\tilde{s}_{t+1+j}$$

- Taylor in FTPL? Coming…

c) New-Keynesian?

$$i_t = \phi\pi_t \;\rightarrow\; E_t\pi_{t+1} = \frac{1+\phi\sigma\kappa}{1+\sigma\kappa}\pi_t$$



- Fed *destabilizes* inflation to select equilibria.
- Fed does not do that.
- Passive fiscal policy. What if s does not go along?
- NK interpretation of everything else is ok.

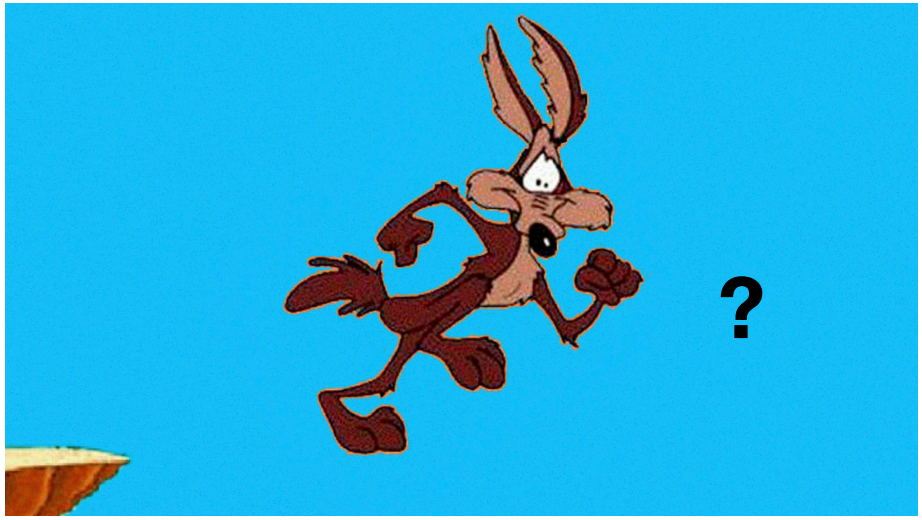
Uncomfortable implications of rational expectations + FTPL (Or NK but paying attention to fiscal implications)

Stable + determinate = long-run *neutrality.*

- A starting point! Like MV=PY; a full theory of the price level under interest rate targets. Beautiful model, inexorable logic. True?

Uncomfortable implications:

- Inflation is stable and determinate under an interest rate peg, k% rule.
- If the Fed raises rates, inflation *eventually* rises.
- If the Fed does nothing or reacts less than 1-1 (and there are no more fiscal shocks!) inflation *eventually* goes away on its own.

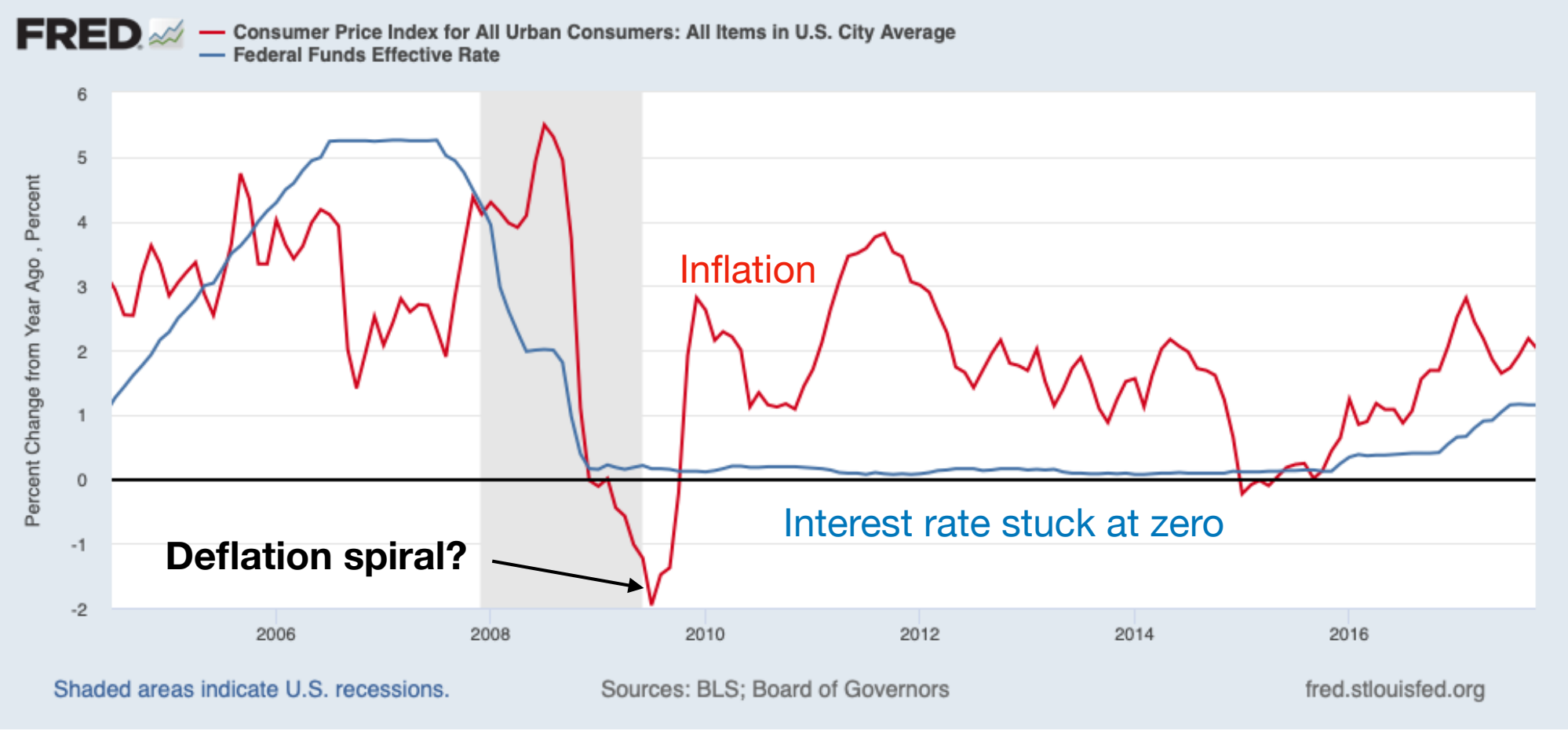


History: long zero bound.
Widely forecast deflation spiral/ sunspots did not occur. …

History: Stable quiet inflation at a peg is possible

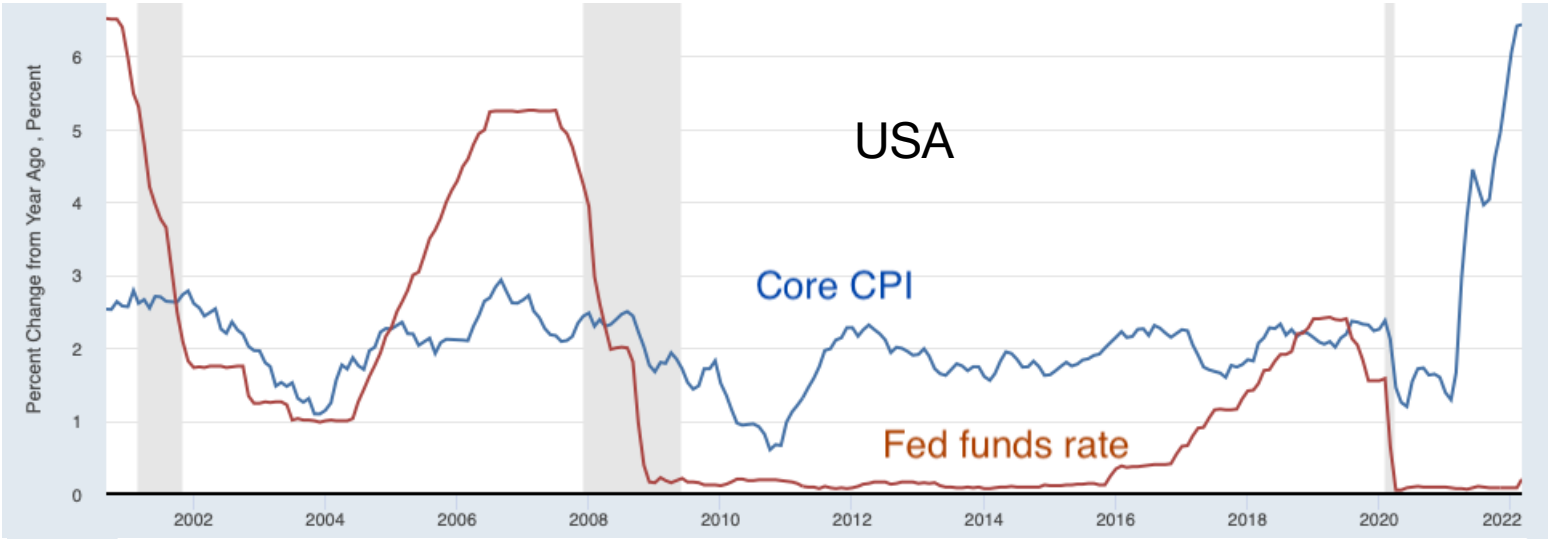
The long quiet zero bound ($\phi = 0$).

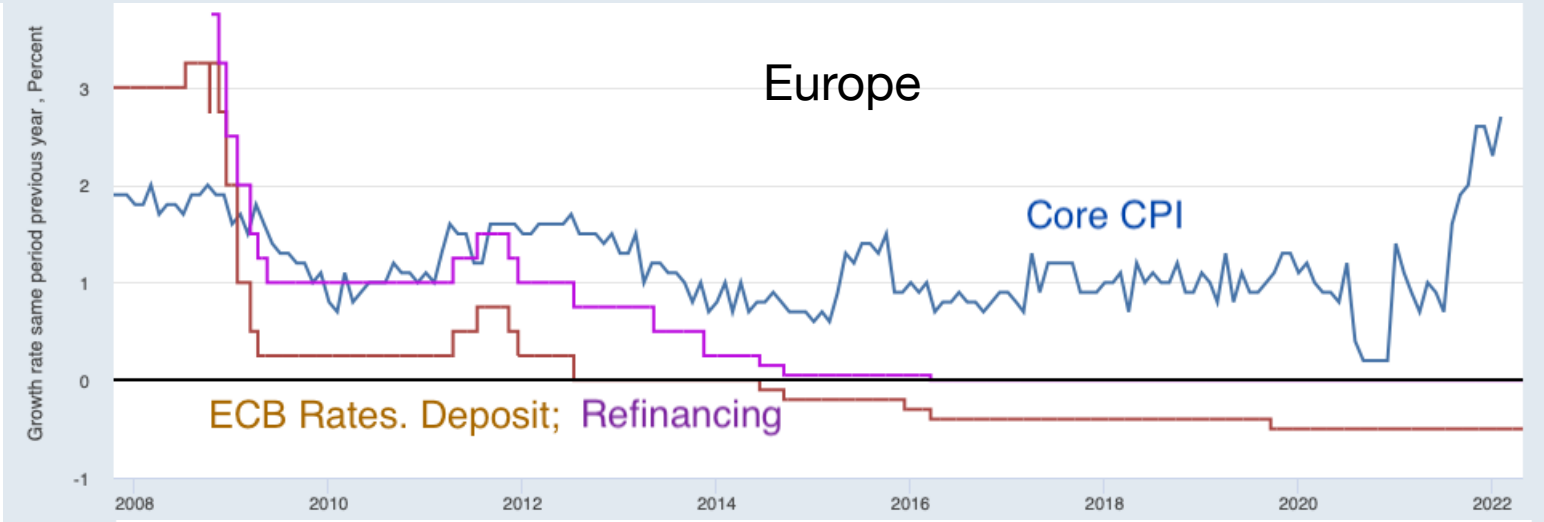
Neither instability (deflation spirals) nor volatility (multiple equilibrium sunspots).

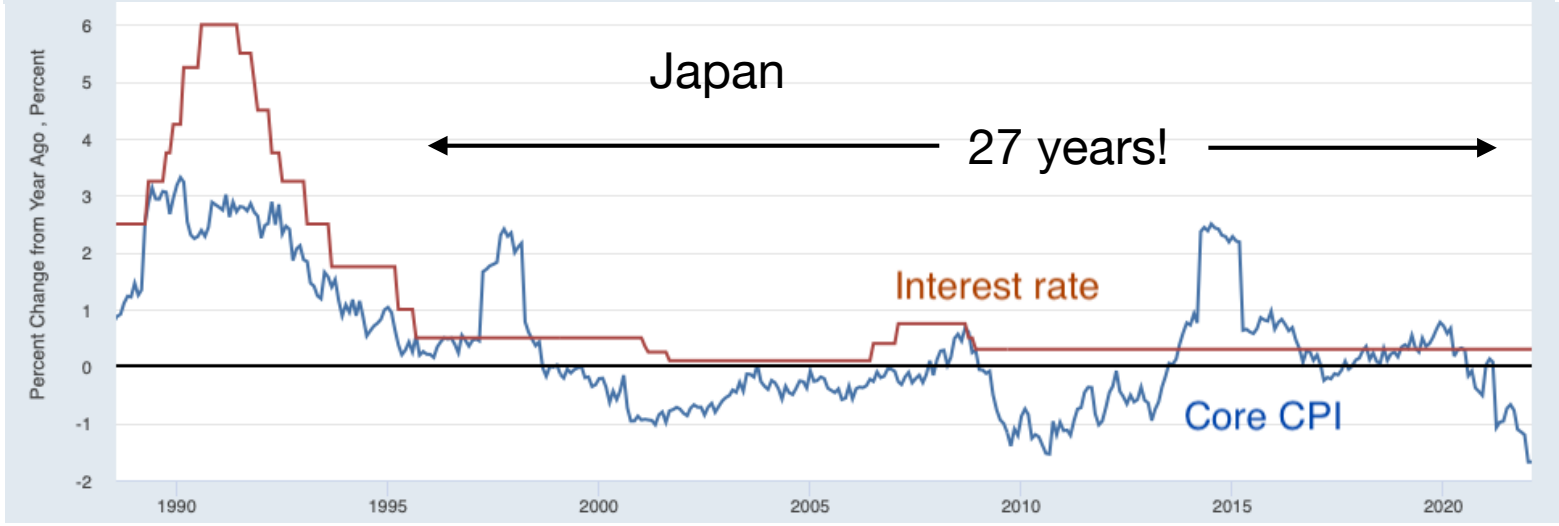


Stable, quiet inflation at a long zero bound — US, Europe, Japan

Other failed pegs? Fiscal problems. (Pegging because of fiscal problems!)



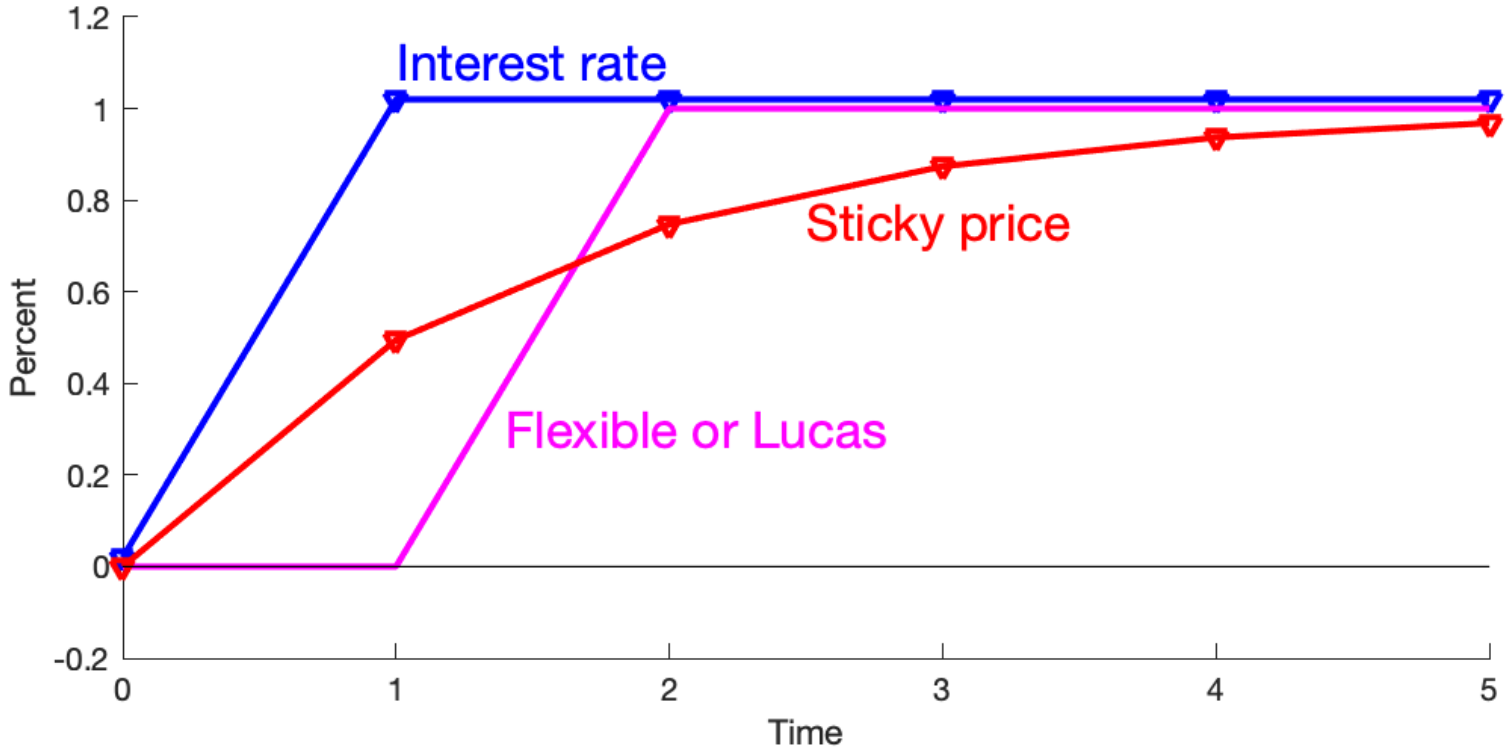




Short run non-neutrality

- Needed: Like Lucas (1972); short-run non-neutrality, higher rates *temporarily* lower inflation.
- That would explain central banker/policy belief in the negative effect. Never saw long-run neutrality (until the ZLB).
- Even not true, we want a theory in which it's possible, then look at necessary ingredients.
- Rules: higher interest rates lower inflation (short run), *without* any change in fiscal policy, with long-run neutrality, neutral limit, economics (model-consistent expectations).
- Rules are designed to understand monetary policy, not to match events or predict policy results. Those *should* include likely contemporaneous fiscal actions and fiscal responses. Also the basic story, on which we build.

Sticky price + rational expectations does not give a negative effect



"Flexible or Lucas" plots $E_t\pi_{t+1} = i_t$ and $\Delta E_{t+1}\pi_{t+1} = 0$.

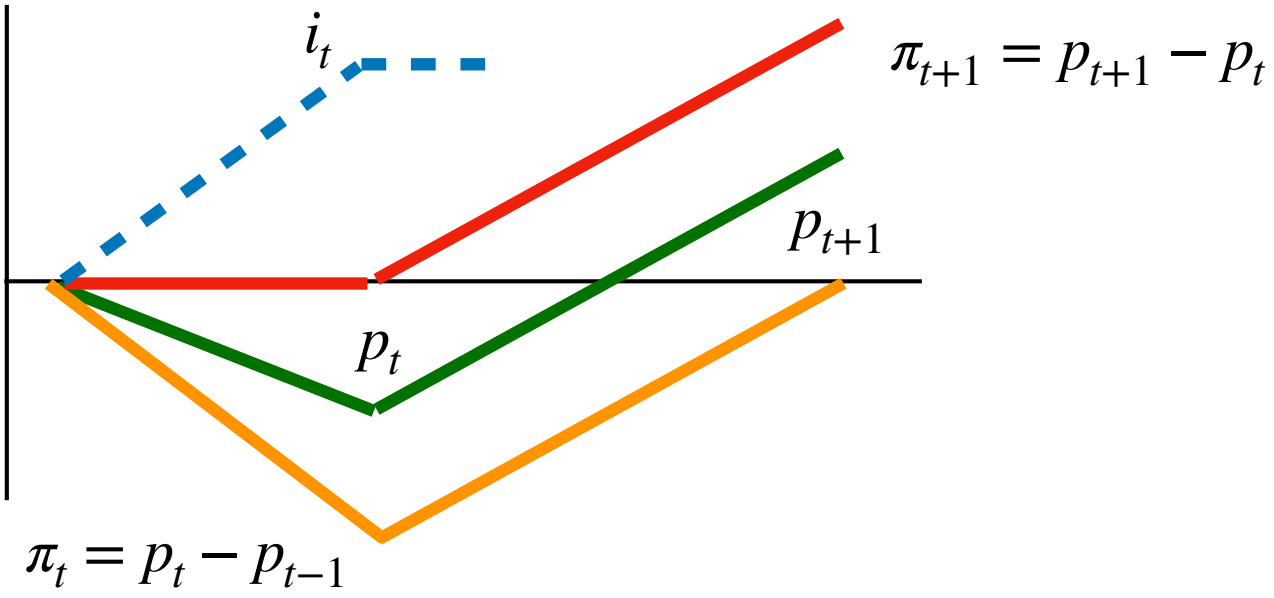
"Sticky Price" plots $E_t\pi_{t+1} = \frac{1}{1+\sigma\kappa}\pi_t + \frac{\sigma\kappa}{1+\sigma\kappa} i_t$ and $\Delta E_{t+1}\pi_{t+1} = \Delta E_{t+1} \sum_{j=0}^{\infty} \rho^j (i_{t+j} - \pi_{t+1+j})$

- Inflation π_1 is *higher*. Interest costs on the debt are paid by devaluing time 0 bonds.
- Yes, non-neutrality and output effects. No, lower inflation.
- This *is* the NK model too.

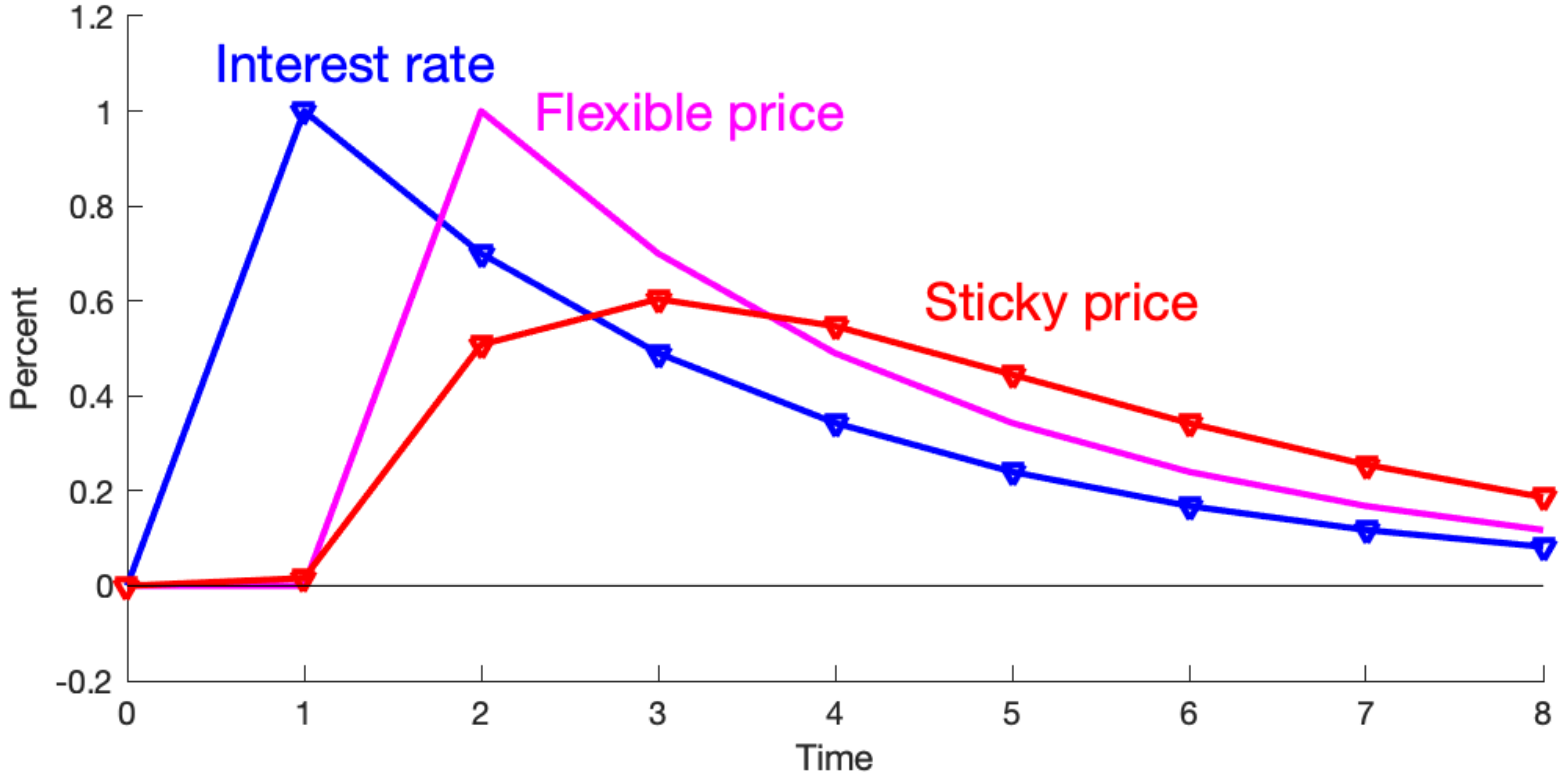
Intuition: Don't higher rates lower demand, inflation?

$$E_t c_{t+1} - c_t = \sigma(i_t - \pi_{t+1})$$

- Higher i_t. Initially p_t, p_{t+1}, π_{t+1} don't change.
- People want more c_{t+1}, less c_t. That pushes p_t down, p_{t+1}, π_{t+1} up. "Intertemporal substitution."
- But is that lower p_t, π_t (current, unexpected) or higher p_{t+1}, π_{t+1}, (future, expected)? "Wealth effect," PV of surpluses.
- Argument confuses p_t, π_t vs. p_{t+1}, π_{t+1}. Proposition is that i_t raises π_{t+1}, intertemporal substitution, natural and hard to overcome.



Transitory interest rate path doesn't help.



"Flexible or Lucas" plots $E_t\pi_{t+1} = i_t$ and $\Delta E_{t+1}\pi_{t+1} = 0.$

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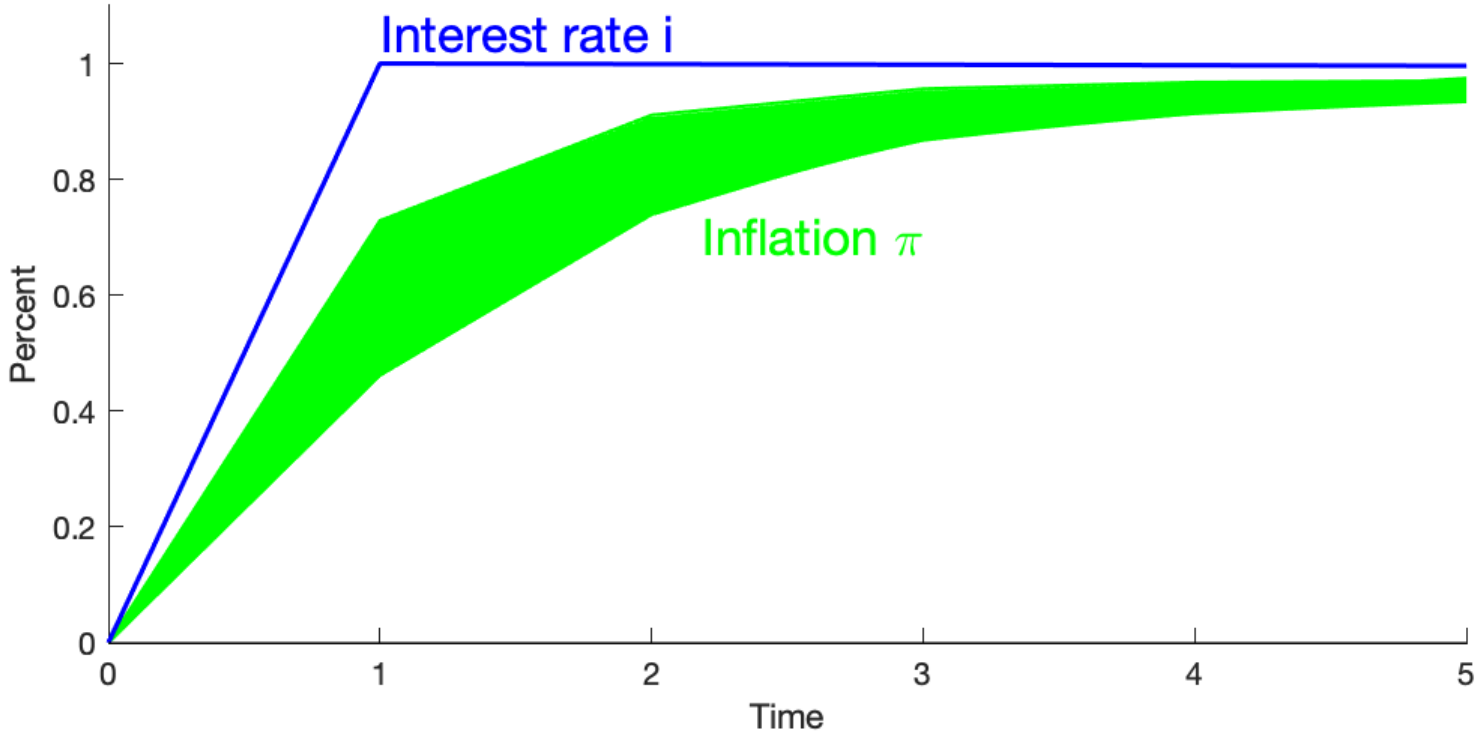
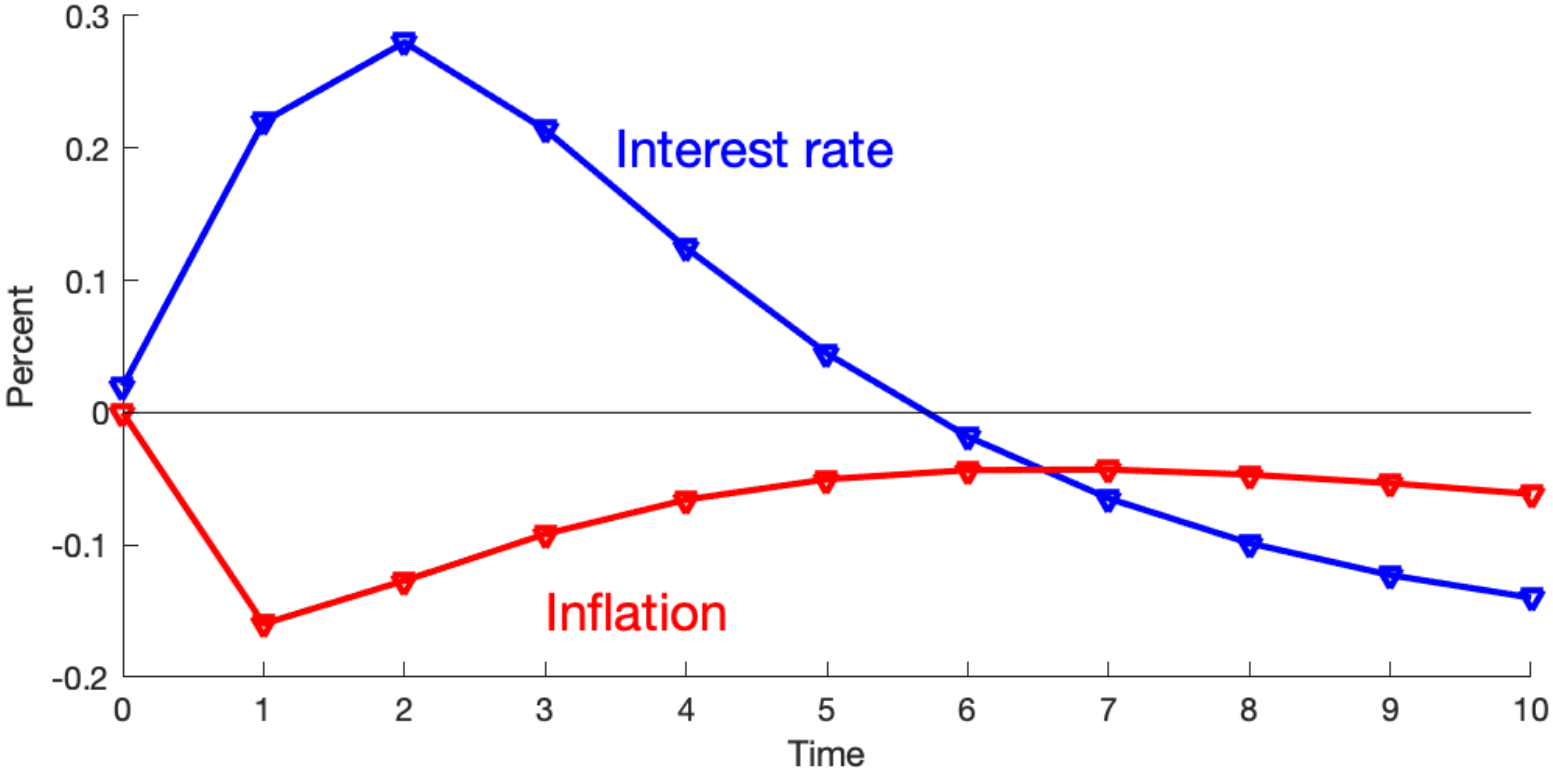
Full model with lagged inflation, all parameters, doesn't help



$$
\begin{aligned}
x_t &= E_t x_{t+1} - \sigma\left(i_t - E_t \pi_{t+1}\right) \\
\pi_t &= (1-\alpha) E_t \pi_{t+1} + \alpha \pi_{t-1} + \kappa x_t \\
\rho v_{t+1} &= v_t + i_t - \pi_{t+1} \\
i_{t+1} &= i_t + \varepsilon_{i,t+1}
\end{aligned}
$$

All parameters σ, κ, α that give real eigenvalues (no zig-zag, sine waves)

Transitory shocks can be misleading

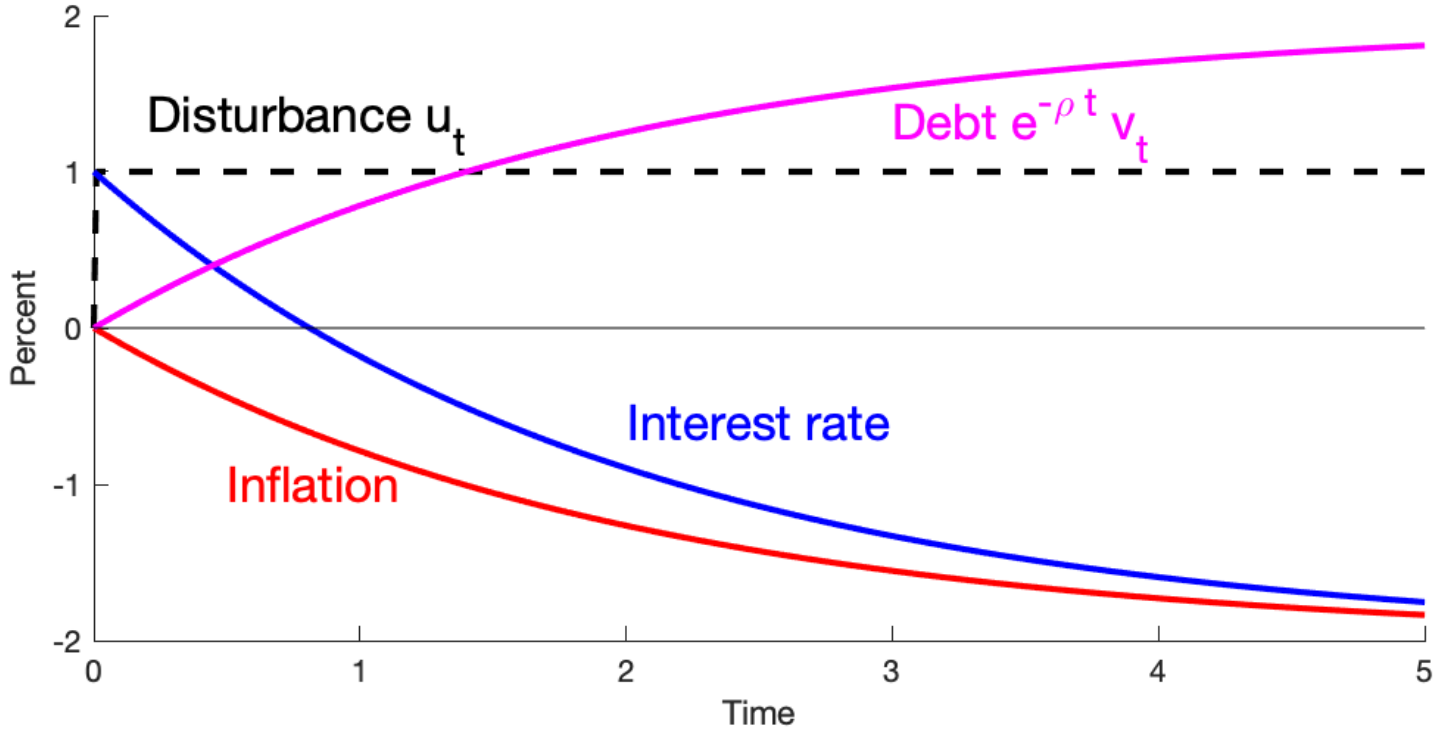


"Inflation" plots $E_t\pi_{t+1} = \dfrac{1}{1+\sigma\kappa}\pi_t + \dfrac{\sigma\kappa}{1+\sigma\kappa}i_t$ and $\Delta E_{t+1}\pi_{t+1} = \Delta E_{t+1}\sum_{j=0}^{\infty}\rho^j(i_{t+j} - \pi_{t+1+j})$

General: $\pi_1 = \dfrac{1-\rho}{1+\sigma\kappa}\sum_{j=1}^{\infty}\rho^j i_j$. $\pi_{t+1} = \dfrac{1-\rho}{(1+\sigma\kappa)^{t+1}}\sum_{j=1}^{\infty}\rho^j i_j + \dfrac{\sigma\kappa}{1+\sigma\kappa}\sum_{j=1}^{t}\dfrac{1}{(1+\sigma\kappa)^{t-j}}i_j$.

- Any positive sequence of nominal interest rates uniformly raises inflation.
- Future negative interest rates drag inflation down now; overall interest costs are negative.
- No "high interest rates lower aggregate demand!"
- This could be what we see in VARs!

Not even adaptive expectations works.

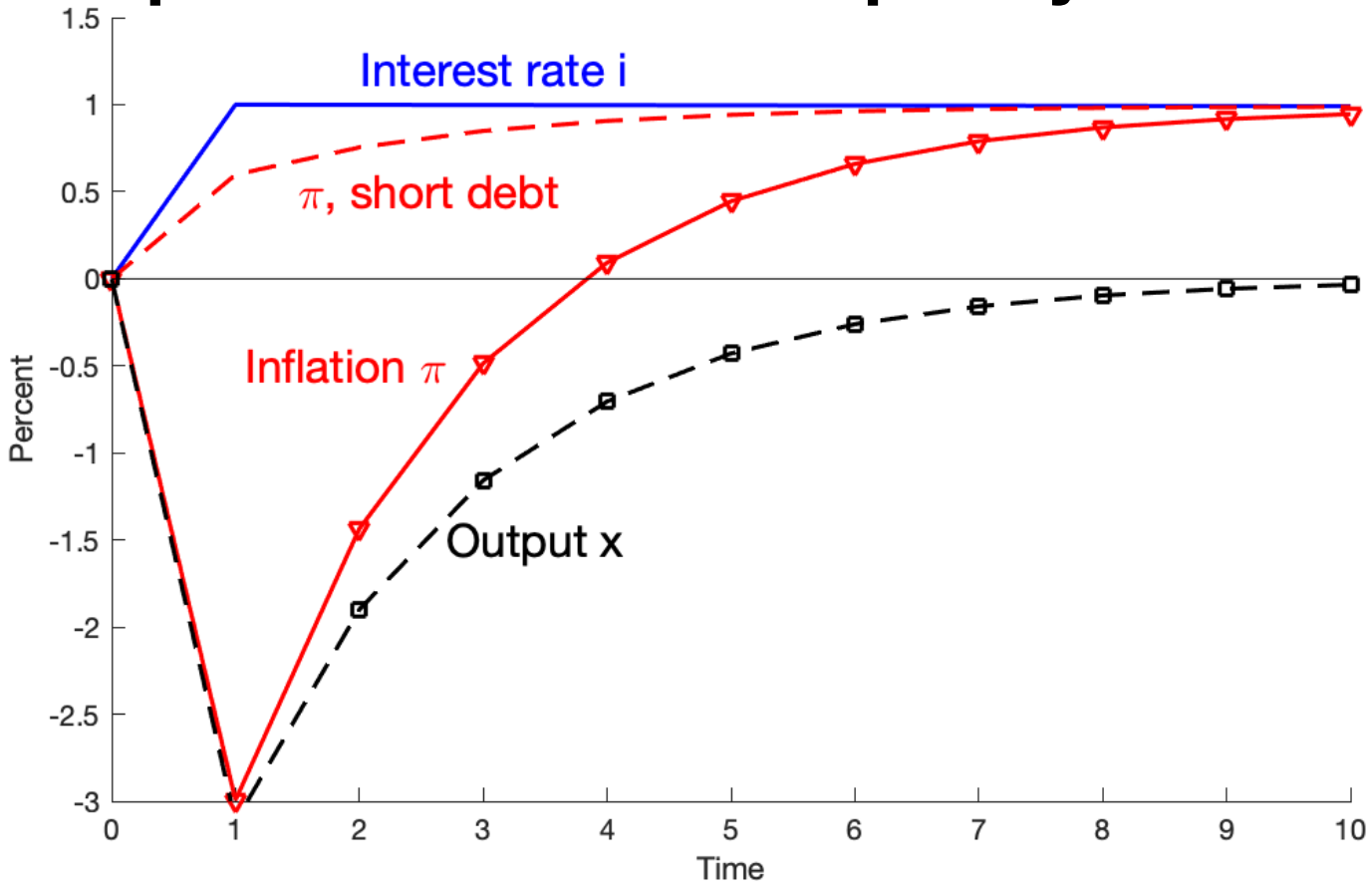


- Disinflation requires interest costs on debt.
- Does not answer our quest, higher interest rates *without* fiscal tightening.
- Paper: for $\rho = 1$ interest rates with no change in fiscal policy *cannot* change long-run inflation. Intuition: average real interest cost on debt = 0 implies average real interest to shove inflation around = 0.

$$x_t = -\sigma(i_t - \pi_{t-1})$$
$$\pi_t = \pi_{t-1} + \kappa x_t$$
$$\rho v_{t+1} = v_t + i_t - \pi_{t+1}$$
$$i_t = \phi \pi_t + u_t$$
$$\sigma\kappa = 1;\ \phi = 1.5\ \rho = 0.99$$

(Continuous time)

An imperfect model of temporary non-neutrality



- Key: long term debt. Lower long-term bond price $Q_t^{(t+j)}$makes short-term debt more valuable

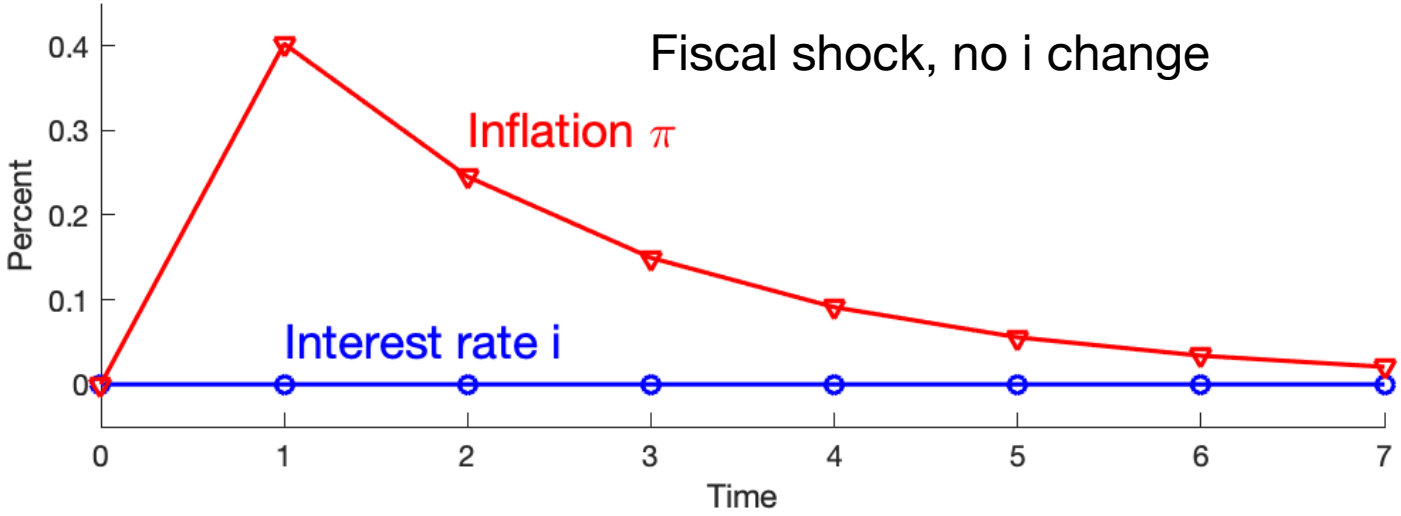
$$\frac{B_{t-1}^{(t)} + \sum_{j=1}^{\infty} Q_t^{(t+j)} B_{t-1}^{(t+j)}}{P_t} = E_t \sum_{j=0}^{\infty} \beta^j s_{t+j} = 0$$

(Calculation includes interest cost/discount rate)

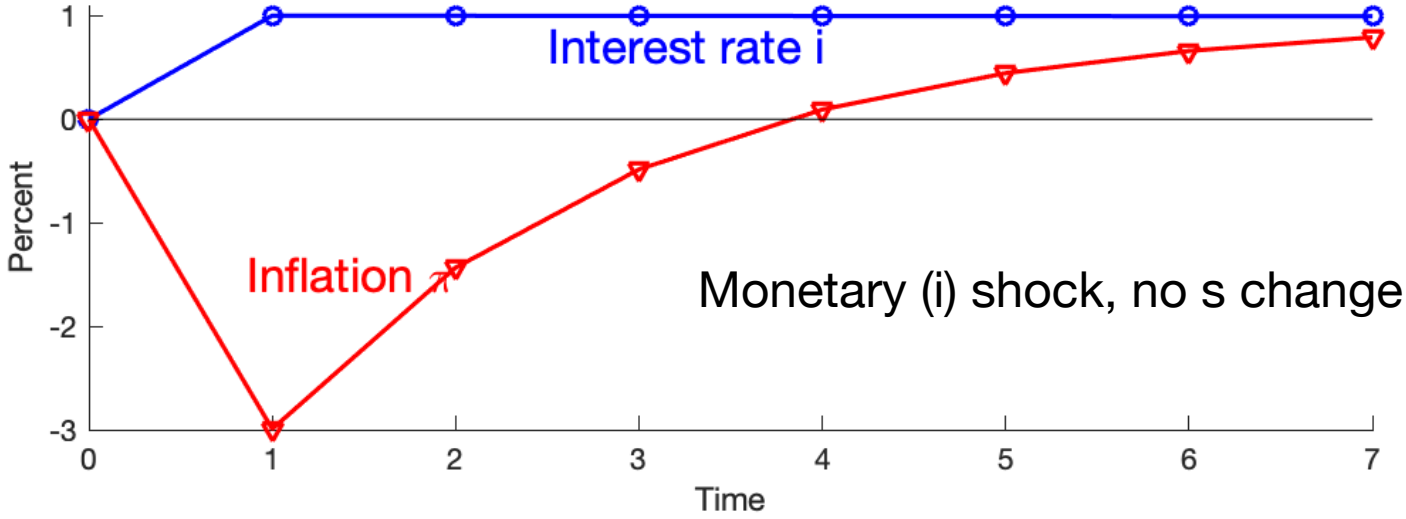
- Stepping on a rake/unpleasant arithmetic.

$$x_t = E_t x_{t+1} - 0.5(i_t - E_t \pi_{t+1})$$
$$\pi_t = E_t \pi_{t+1} + 0.5 x_t$$
$$i_t = i_{t-1} + \varepsilon_{i,t}$$
$$\rho v_{t+1} = v_t + r_{t+1}^n - \pi_{t+1} - \tilde{s}_{t+1}$$
$$E_t r_{t+1}^n = i_t$$
$$r_{t+1}^n = 0.9 q_{t+1} - q_t$$

FTPL digression



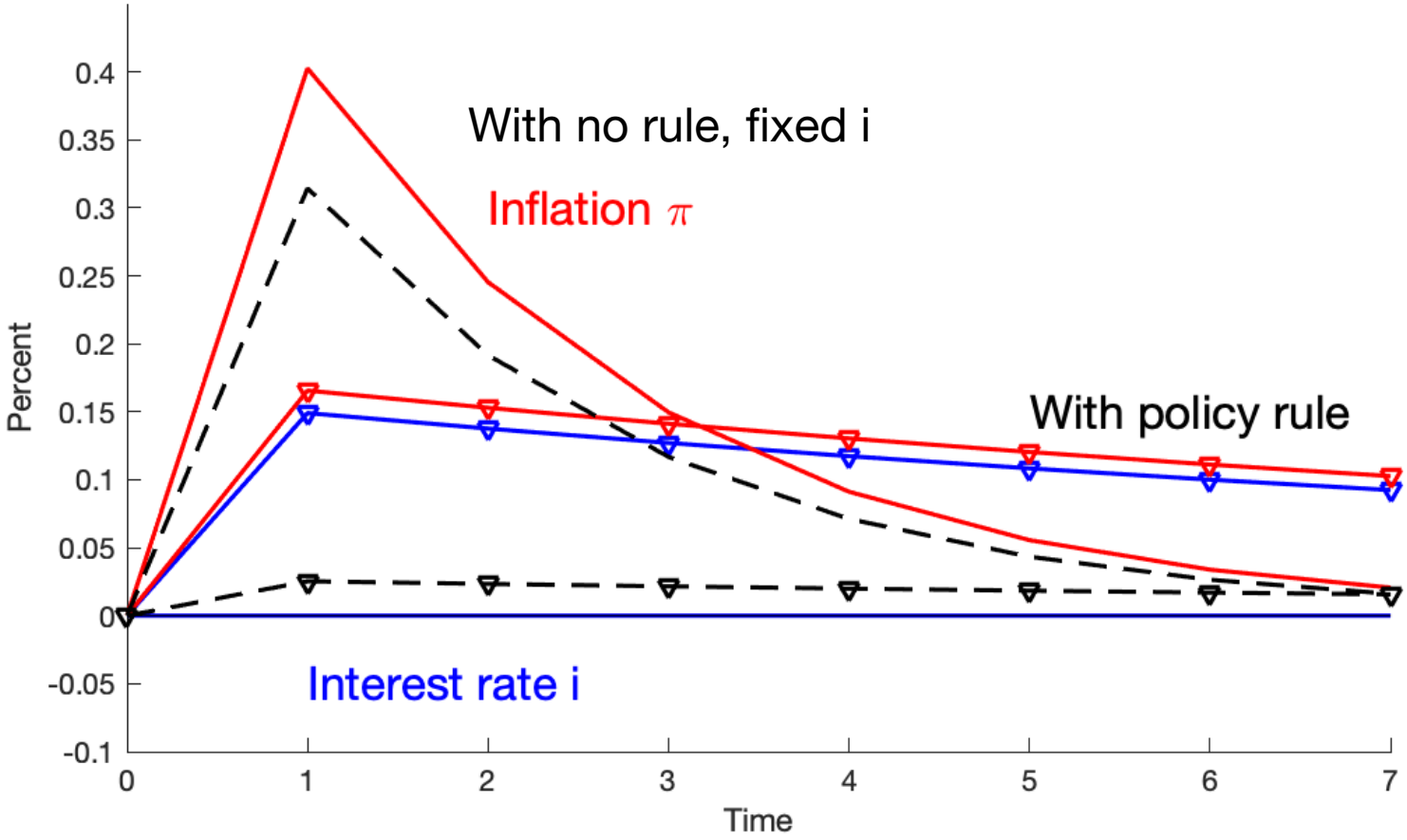
Inflation does fade, if the Fed does nothing. (And no more shocks!) Cumulative low returns drain bondholder value, not price level jump.



Monetary policy can rearrange inflation over time and achieve any long-run expected inflation (once debt rolls over, $i_t = E_t \pi_{t+1}$.)

Now add: What if Fed reacts to a fiscal shock with higher interest rates?

Taylor Rule in FTPL models

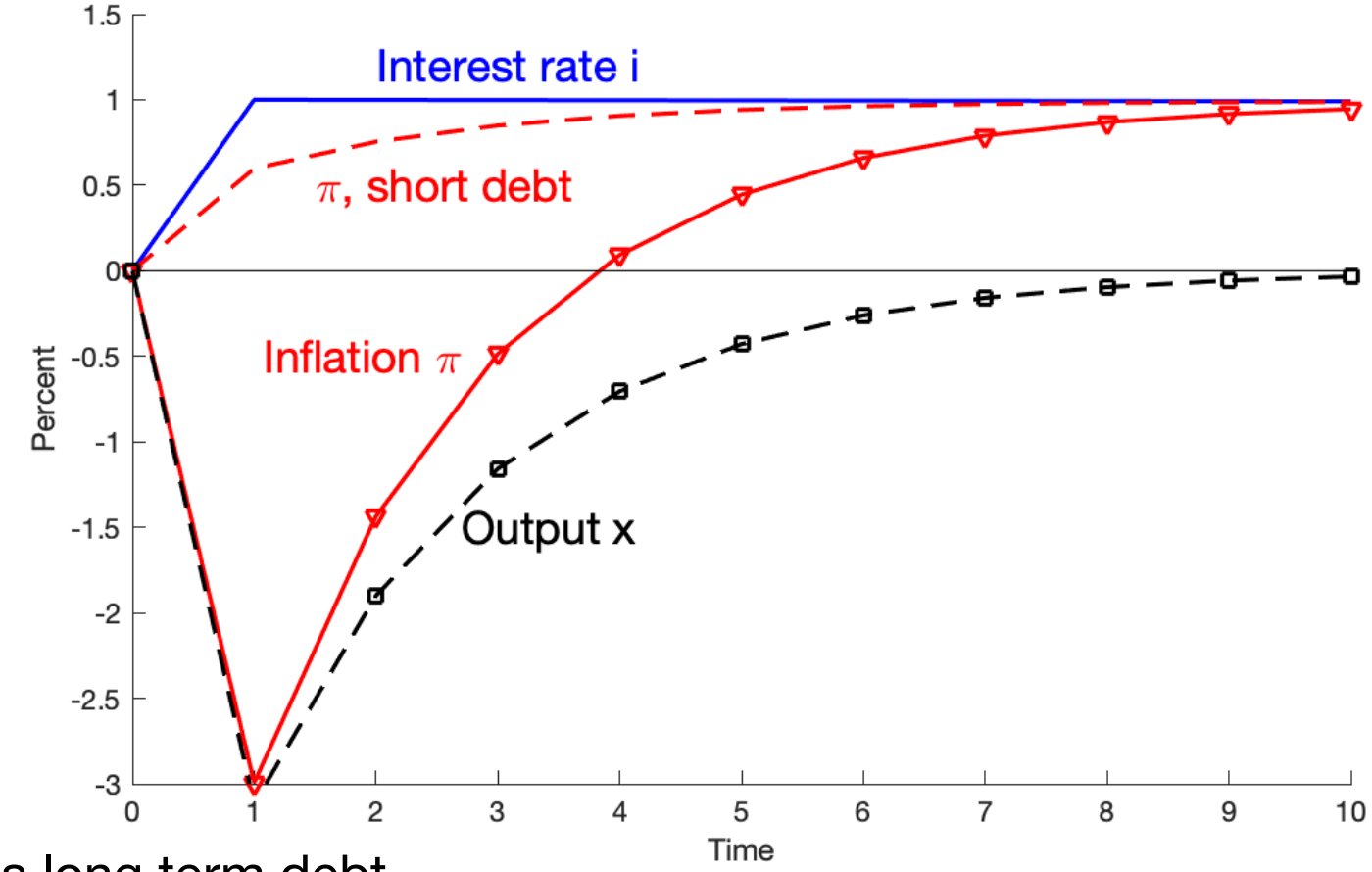


Response to a fiscal shock with a monetary rule, $i_t = \phi \pi_t$

- Adaptive: Taylor rule stabilizes an unstable model
- New Keynesian: Taylor rule brings determinacy to indeterminate model
- FTPL: Taylor rule reduces output and inflation volatility

Current events: Fed will lower inflation, at the cost of prolonging it.

An imperfect model of temporary non-neutrality



But:

- Needs long term debt.
- Stickier prices *reduce* the effect. (Interest costs.)
- Only an unexpected, persistent rate rise, on announcement not when the rates rise.
- Too sudden/strong (relative to VARs).
- Unexpected inflation, not lower expected inflation; not short run adaptive/ long run rational.
- Still a “wealth” effect not “real interest rate” effect.
- Not Lucas holy water on monetarist/ISLM intuition!

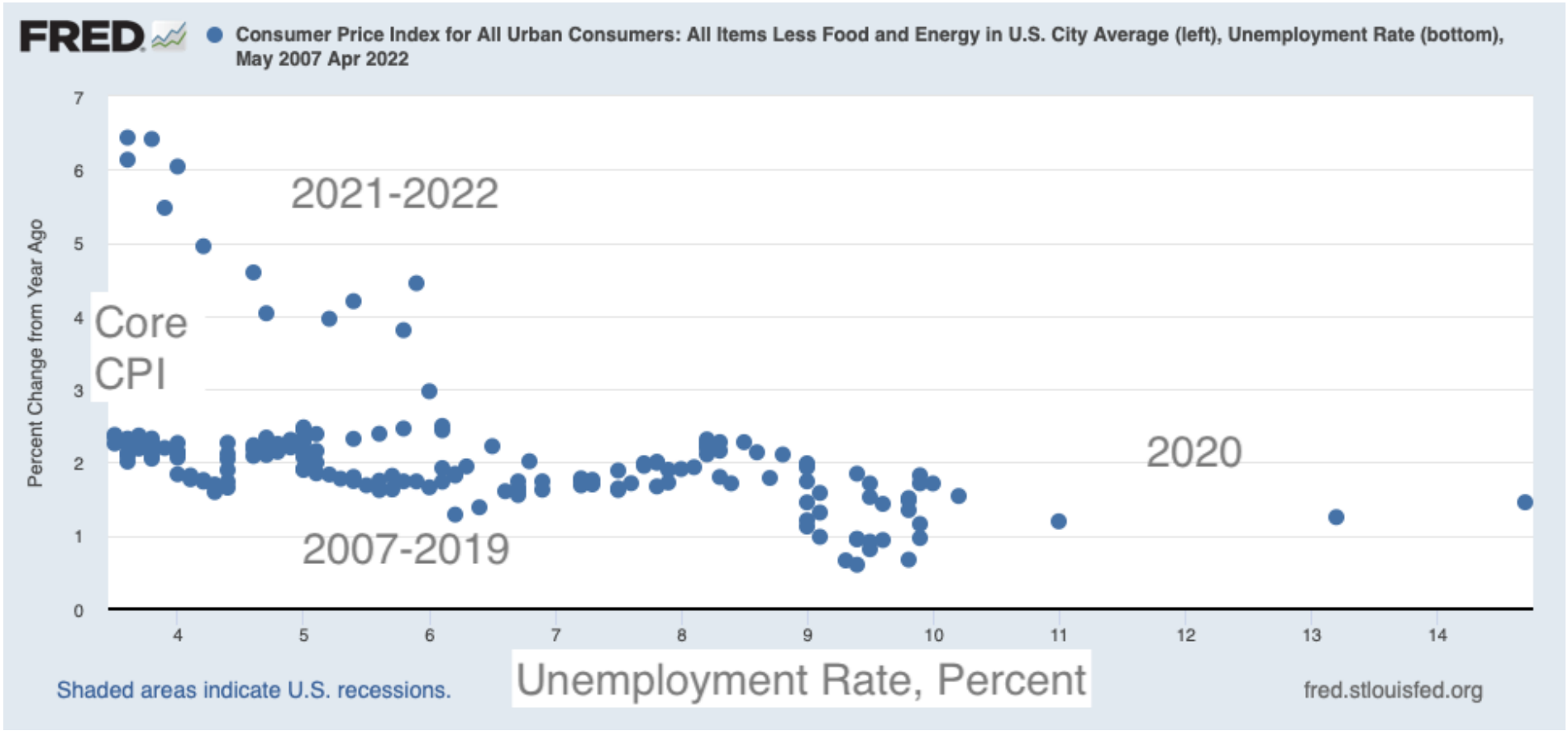
$$x_t = E_t x_{t+1} - 0.5(i_t - E_t \pi_{t+1})$$
$$\pi_t = E_t \pi_{t+1} + 0.5 x_t$$
$$i_t = i_{t-1} + \varepsilon_{i,t}$$
$$\rho v_{t+1} = v_t + r^n_{t+1} - \pi_{t+1} - \tilde{s}_{t+1}$$
$$E_t r^n_{t+1} = i_t$$
$$r^n_{t+1} = 0.9 q_{t+1} - q_t$$

Needed: Lucas (2022). Expectations and the (temporary non-) neutrality of interest rates

- Irrational / complex / model-inconsistent expectations? As a *necessary* ingredient for the *sign* of monetary policy?
- Stability, determinacy, long run neutrality are deeper and desirable properties.
- Tests are not so easy. Rational can seem adaptive $\pi_t^e = \Sigma a_j \pi_{t-j}$. The rational expectations point is only that parameters $\{a_j\}$ change.
- DSGE smorgasbord? (Investment, credit constraints, financial frictions, heterogeneity, etc. etc.) Yes! But what is the minimal, robust, economically *necessary* set of ingredients/frictions for a negative short run effect? Intuition please? (Yes, please!)

Needed: Lucas (2022). Beyond the Phillips curve?

- Us: How do nominal interest rates affect inflation? (Then output?) We use Phillips curve; $x_t = -\sigma(i_t - E_t\pi_{t+1})$ and $\pi_t = E_t\pi_{t+1} + \kappa x_t$
- Current Phillips curves have theory & empirical shortcomings. Relation between all prices, wages and output? (Confuse relative with absolute price level?) Basic sign, output with inflation rising or falling? $\pi_t = E_t\pi_{t+1} + \kappa x_t$ vs. $\pi_t = \pi_{t-1} + \kappa x_t$



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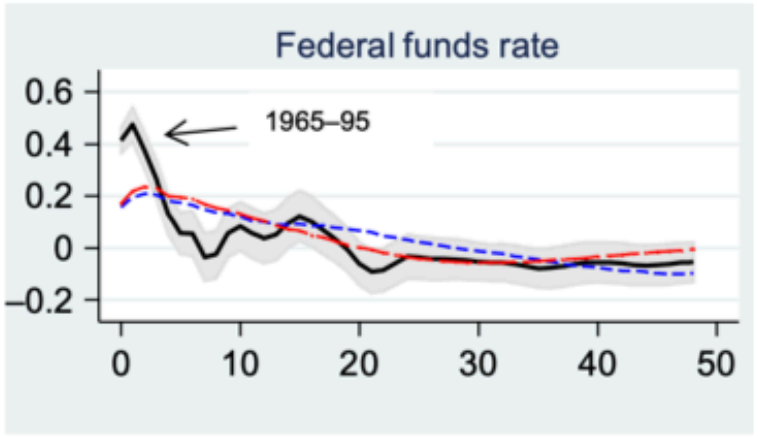
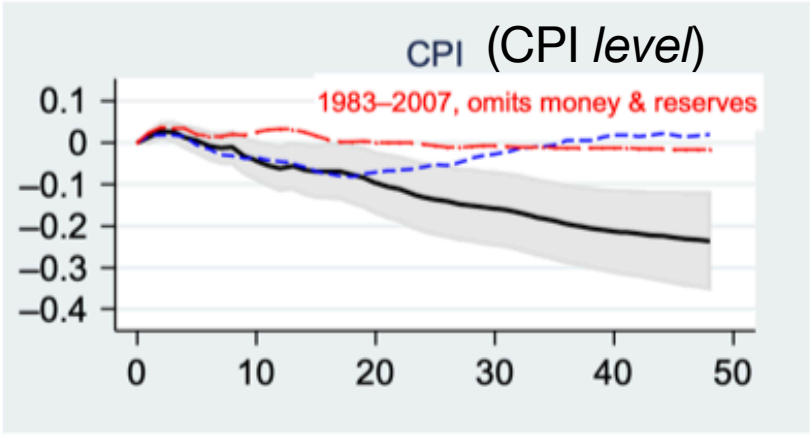
- Lucas: How does *inflation* affect *output*? Not how does money affect inflation. Not designed for our purpose.
- Attack $\pi_t = a(L)i_t + \varepsilon_t$ directly? Abandon Phillips curve (for this purpose)? Production network models?
- $i_t = r_t + E_t\pi_{t+1}$ is harder than $m_t + v = p_t + y_t$ because r_t must decline more than 1-1. (If the goal is lower expected inflation).
- Or, maybe, the negative sign (without fiscal policy) isn't true?

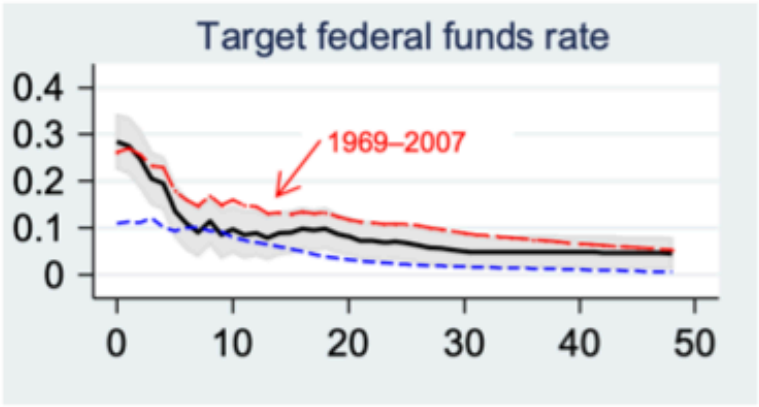
Estimates of the effects of higher interest rates

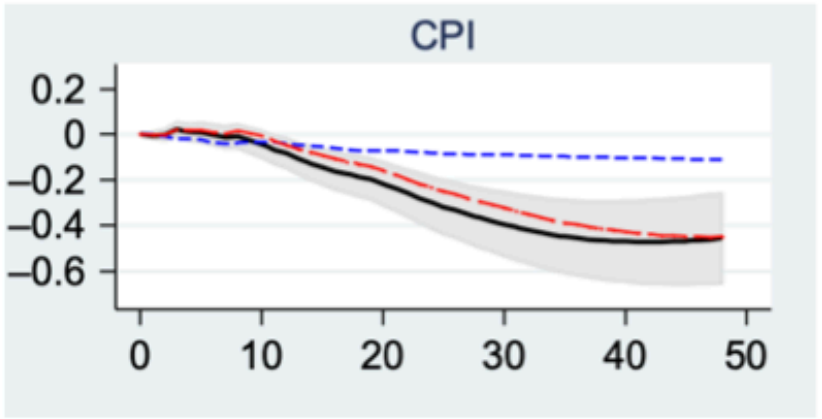
VAR





Romer-Romer





Source: Ramey (2016)

- Slow delayed inflation decline, not AR(1). If at all! *This* is the Fed's big stick?

But

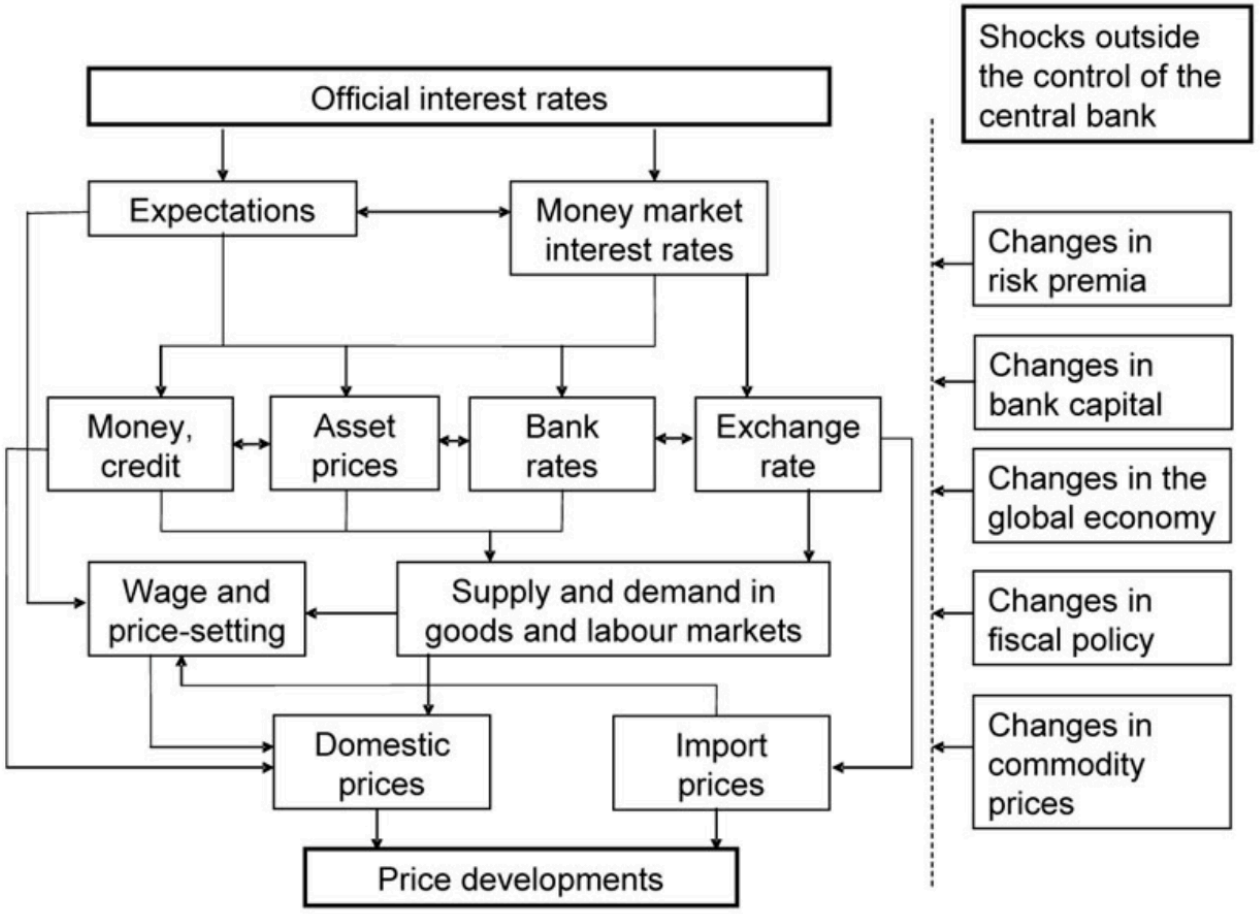
- Only one, average, small, value of funds rate persistence.
- Does not try to hold fiscal policy fixed — at time of shock or in response. It could well be true with contemporary fiscal shocks and responses, but not without them. Estimates that hold fiscal policy constant are low-hanging fruit.
- By design, leaves out changes in regime that change expectations.

Bottom line

- 50 years on. Lots achieved. Lots unknown. Lots to do.
  - We have an economic theory of stable & determinate inflation with an interest rate target. Long run neutrality and frictionless limit. A starting point.
  - Do we believe it? *Is* inflation stable and determinate under an interest rate peg? Is long run neutrality right? K percent rule, long-run positive sign? If not, what is the economic theory of inflation under interest rate targets?
  - Theory need: A better model of the short-run negative effect (without fiscal policy!) if there is one.
  - Empirical need: Is there a short-run negative effect and how?
  - What are fiscal-monetary interactions for Fed, US? Does fiscal policy pay interest costs on the debt? How does Fed affect inflation if fiscal policy responds to a recession with bailout and deficit?
- Policy advice: With basic economic story, stability and sign contentious, a little humility…

The ECB's view of how monetary policy affects inflation

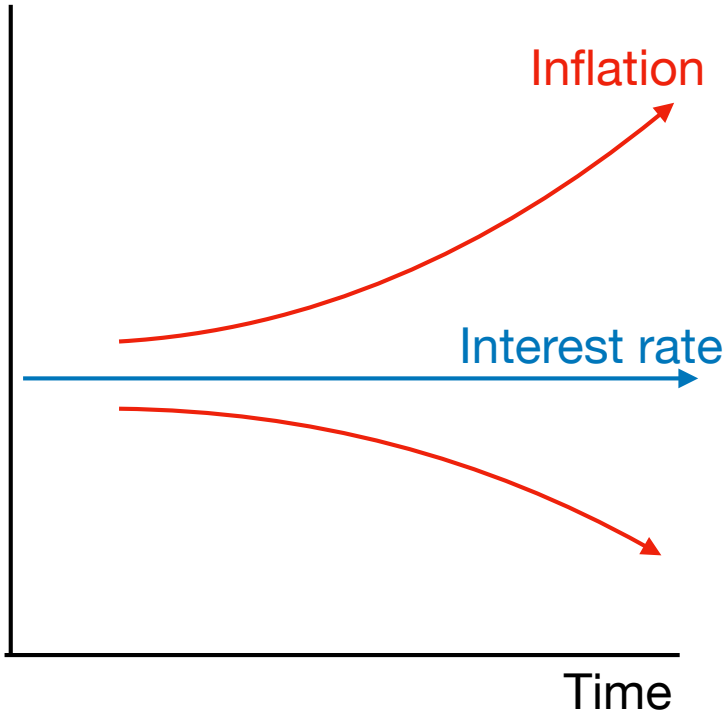
The chart below provides a schematic illustration of the main transmission channels of monetary policy decisions.



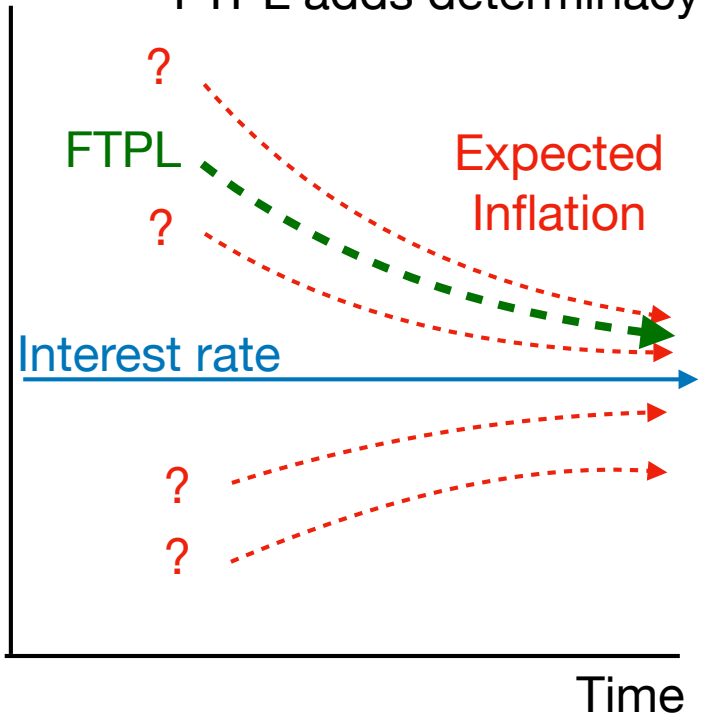
Source: https://www.ecb.europa.eu/mopo/intro/transmission/html/index.en.html

Note somewhere: super rational looks a lot like super adaptive

Adaptive expectations.
Unstable (determinate)



Rational expectations.
Stable, indeterminate
FTPL adds determinacy



Theory of inflation under interest rate targets

Model $x_t = E_t x_{t+1} - \sigma(i_t - \pi_t^e)$ ⟵ In place of $m_t + v = p_t + x_t$

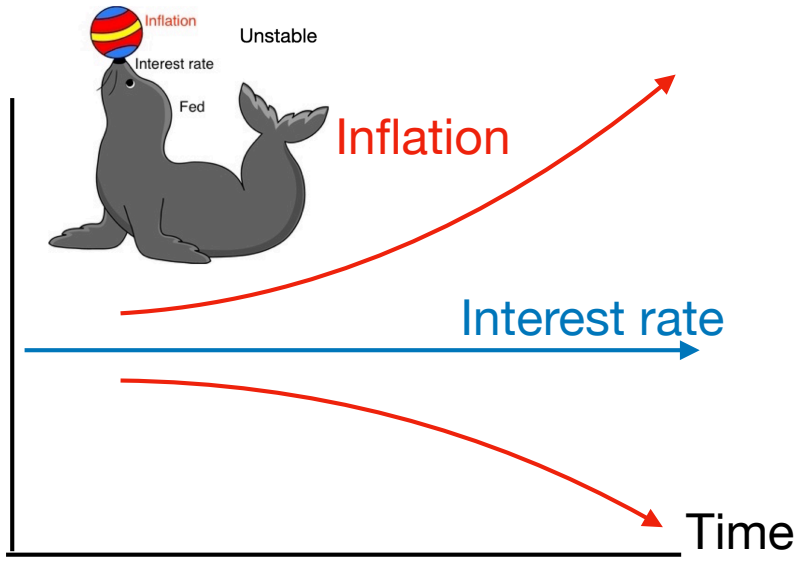
$\pi_t = \pi_t^e + \kappa x_t$

Inflation dynamics $\pi_t = (1 + \sigma\kappa)\pi_t^e - \sigma\kappa i_t\,.$

Adaptive $\pi_t^e = \pi_{t-1}$

$\pi_t = (1 + \sigma\kappa)\pi_{t-1} - \sigma\kappa i_t\,.$

Friedman (1968): i target is *unstable.*



Taylor rule? $i_t = \phi\pi_t$

$$\pi_t = \frac{1 + \sigma\kappa}{1 + \sigma\kappa\phi}\pi_{t-1}\,.$$

Fed stabilizes inflation with adaptive E.

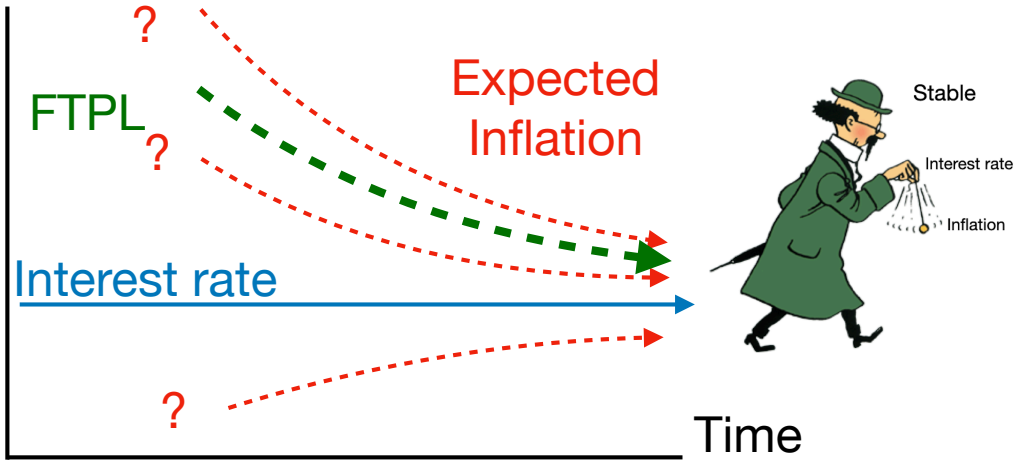
Rational $\pi^e = E_t\pi_{t+1}$

$$E_t\pi_{t+1} = \frac{1}{1 + \sigma\kappa}\pi_t + \frac{\sigma\kappa}{1 + \sigma\kappa}i_t$$

Sargent Wallace (1975): *Stable*, *indeterminate.*

FTPL $\Delta E_{t+1}\pi_{t+1} = \sum_{j=0}^{\infty} \rho^j \Delta E_{t+1}(-\tilde{s}_{t+1+j} + r_{t+1+j})$

Inflation is stable and determinate (at last).



Inflation is not always and everywhere monetary.

New-Keynesian? $\phi > 1$ Fed destabilizes inflation to select equilibria.