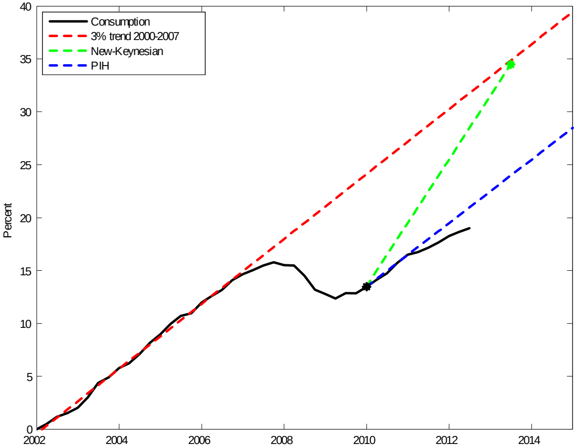
The New-Keynesian Liquidity Trap

John H. Cochrane

Univeristy of Chicago Booth School of Business

New Keynesian models: Diagnosis

- Consensus NK diagnosis: "Natural" rate $r << 0$ (?), $i = 0$, $\pi = 2.5\%$, $i - \pi$ too high.
- Fix $E_t c_{t+\infty}$. "Too high" real rate $\rightarrow$ consumption grows too fast, level too low.
- Why do we not see more $\pi = -r$? $\rightarrow$ model.



New Keynesian models: Policy

- Policy: All the laws of economics change sign at the zero bound.
    1. Open mouth operations, forward guidance, commitments work. *Further* in the future has *larger* effect today.
    2. *Expected* inflation is good, raises output.
    3. Totally wasted government spending, even if financed by taxes, can have arbitrarily high multipliers.
    4. Capital destruction, technical regress, hurricanes, broken windows are good.
    5. All get *stronger* as price frictions *diminish*, with ∞ limit.
    6. $\rightarrow$Though stickiness is the central friction causing our troubles, don't fix it! Making prices sticker is good.
- And if you don't agree, you're (unprintable)
- NK model is *not* Paleo-Keynesian. MPC $= 0$. Intertemporal substitution.

$$c_t = E_t \lim_{T\to\infty} c_{t+T} - \sigma^{-1} \int_{s=0}^{\infty} \left(i_{t+s} - r_{t+s} - \pi_{t+s}\right) ds$$

This paper

- Write down the model. Confirm NK diagnosis & policy predictions.
- Show they come from one, particular, arbitrary equilibrium choice. "Most" (plausible?) equilibria do not have these features.
- NK/Taylor choice: Fed has *two, independent* policy tools: interest rate policy and equilibrium-selection policy.
  1. All the predictions come from expectations of *equilibrium selection* policy, not *interest rate* policy.
  2. Look at it. Does anyone have these expectations of equilibrium selection policy?
- Play by NK rules of the game. Complain about the model/find correct model some other day.
- Simplest possible model to show the basic mechanisms. Not realistic/match to data.
- Bottom line: Save the NK model, not criticize it!

New Keynesian Model (Werning 2012)

$$\frac{dx_t}{dt} = \sigma^{-1}(i_t - r_t - \pi_t) \quad (1)$$

$$\frac{d\pi_t}{dt} = \rho\pi_t - \kappa x_t. \quad (2)$$

$$r_t = \text{“natural” rate}$$

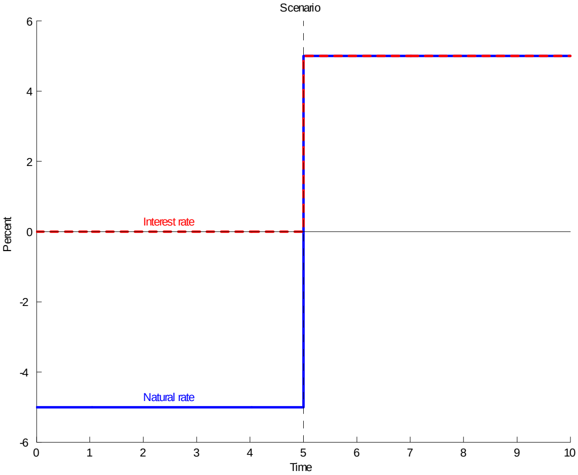
From

$$\begin{aligned} x_t &= E_t x_{t+1} + \sigma^{-1}\left[i_t - r_t - E_t\pi_{t+1}\right] \\ \pi_t &= e^{-\rho}E_t\pi_{t+1} + \kappa x_t \end{aligned}$$

or

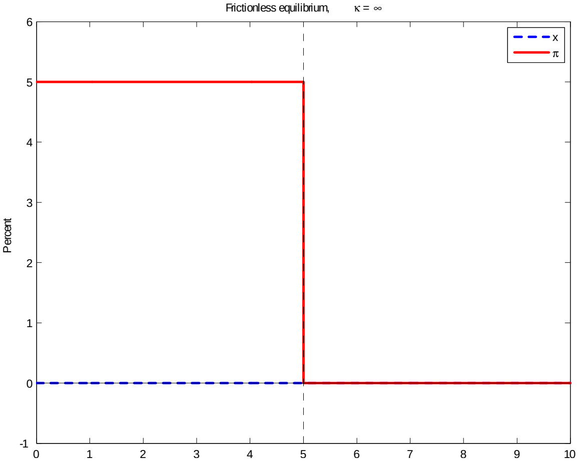
$$\pi_t = \kappa\int_{s=0}^{\infty} e^{-\rho s}x_{t+s}\,ds$$

Scenario



$$
\begin{aligned}
i_t - r_t &= ir_t > 0;\ \ t < T; \\
i_t - r_t &= ir_t = 0; t > T.
\end{aligned}
$$

The frictionless equilibrium



$$x_t = \frac{1}{\kappa}\left(\rho\pi_t - \frac{d\pi_t}{dt}\right) . \kappa \to \infty; \; x_t = 0$$

$$i_t - r_t = \pi_t$$

Solution with price stickiness

$$\frac{d}{dt}\begin{bmatrix} x_t \\ \pi_t \end{bmatrix} = \begin{bmatrix} 0 & -1 \\ -\kappa & \rho \end{bmatrix}\begin{bmatrix} x_t \\ \pi_t \end{bmatrix} + \begin{bmatrix} ir_t \\ 0 \end{bmatrix}$$

- $t > T$ $(ir_t = 0)$

$$\begin{bmatrix} \kappa x_t \\ \pi_t \end{bmatrix} = \begin{bmatrix} \lambda^p & \lambda^m \\ 1 & 1 \end{bmatrix}\begin{bmatrix} e^{\lambda^m(t-T)} z_T \\ e^{\lambda^p(t-T)} w_T \end{bmatrix}; \qquad \begin{matrix} \lambda^m < 0 \\ \lambda^p > 0 \end{matrix}$$

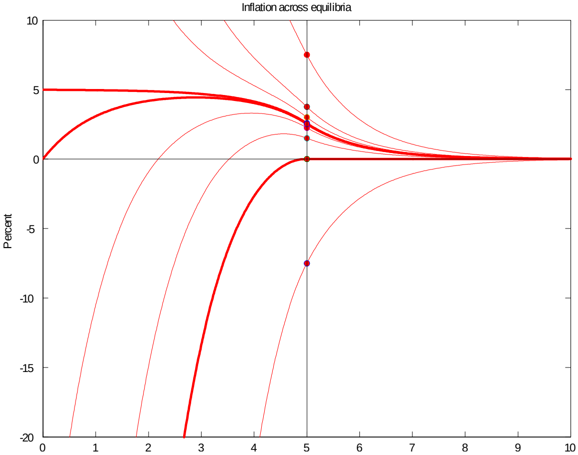
  $w_T = 0$ (no quarrel today). Leaves $z_T = \pi_T$, multiple stable equilibria $e^{\lambda^m(t-T)}\pi_T$, index by π_T

- $t < T$: choose z_T, w_T to paste at π_T.

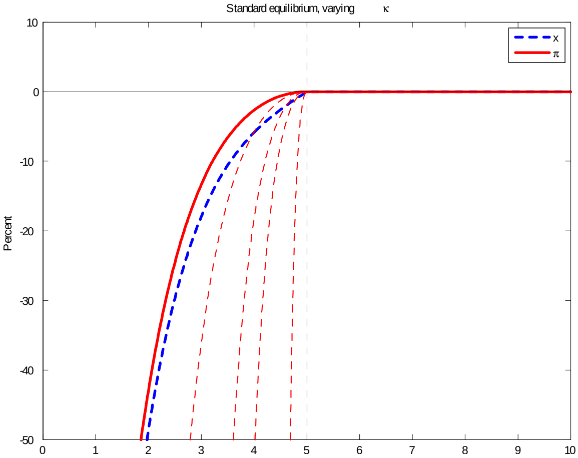
$$\begin{bmatrix} \kappa x_t \\ \pi_t \end{bmatrix} = ir\begin{bmatrix} \rho \\ 1 \end{bmatrix} - ir\begin{bmatrix} \cdot & \cdot \\ \cdot & \cdot \end{bmatrix}\begin{bmatrix} e^{\lambda^m(t-T)} \\ e^{\lambda^p(t-T)} \end{bmatrix} + \pi_T\begin{bmatrix} \lambda^p \\ 1 \end{bmatrix} e^{\lambda^m(t-T)}.$$

- Both $e^{\lambda^m(t-T)}$ and $e^{\lambda^p(t-T)}$ terms are potentially active. $e^{\lambda^m(t-T)}$ explode going *back* in time. $\{\pi_T\}$ adds $e^{\lambda^m(t-T)}$ terms.

Inflation in all equilibria

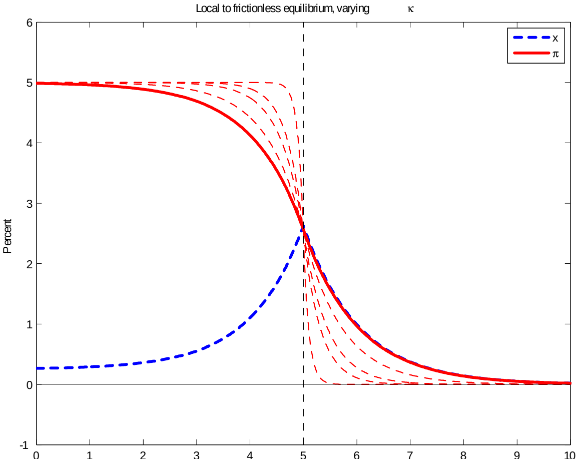


The standard equilibrium choice



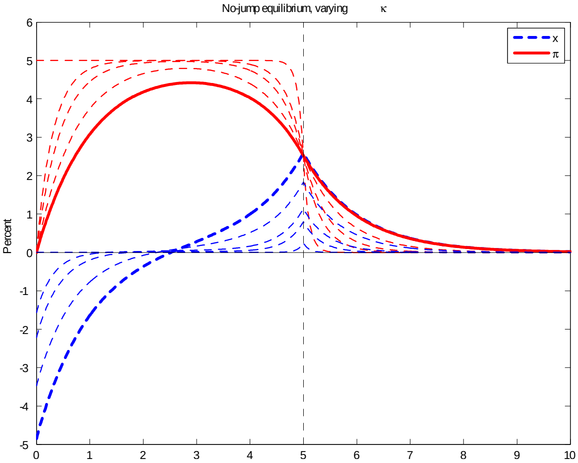
- $\pi_T = 0$; backward-explosive eigenvalue. Root of all wild predictions.
- Depression (with growth). Deflation. Less friction→worse.

The backwards-stable equilibrium



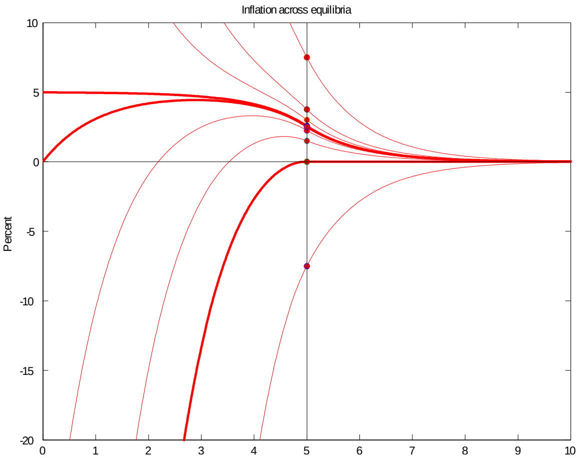
- π_T: no *backward* explosions. $\rightarrow$ Nice frictionless limit
- *Exactly the same interest rate policy.*
- $E_t \pi_T = 0$ with no glide path assumption has big implications!

The no-inflation-jump equilibrium

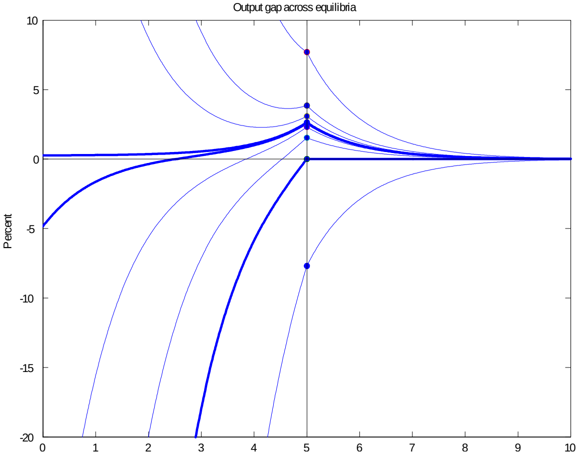


- $\pi_T : \pi_0 = 0$.
- Not deflation.
- *All* equilibria with limited π_0 jump have normal limits.

Inflation in all equilibria



Output gaps in all equilibria



Magical multipliers and paradoxical policies

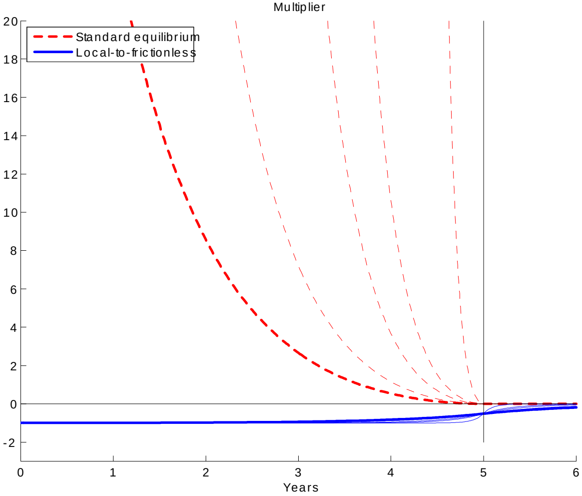
$$\frac{d\pi_t}{dt} = \rho\pi_t - \kappa\left(x_t + g_t\right).$$

- $g =$ totally useless spending, technical regress, high wage mandates, capital destruction, etc.
- π channel, not consumption function. All else constant, more g means more π, less $i - r$. $\{\pi_t\}$ constant means $\partial x/\partial g = -1$
- Consider $g_t = g > 0$ for $t < T$, then $g_t = 0$ for $t > T$. The solution is unaffected $t > T$. For $t < T$:

$$\begin{bmatrix} \kappa x_t \\ \pi_t \end{bmatrix} = (ir_t) - \begin{bmatrix} \kappa g \\ 0 \end{bmatrix} + \begin{bmatrix} \cdot & \cdot \\ \cdot & \cdot \end{bmatrix} \begin{bmatrix} e^{\lambda^m (t-T)} \\ e^{\lambda^p (t-T)} \end{bmatrix} \kappa g + \begin{bmatrix} \lambda^p \\ 1 \end{bmatrix} \pi_T(g) e^{\lambda^m (t-T)}$$

- Calculate $\partial x_t/\partial g$, private-output multiplier. Steady state, $\partial x/\partial g = -1$. With π....

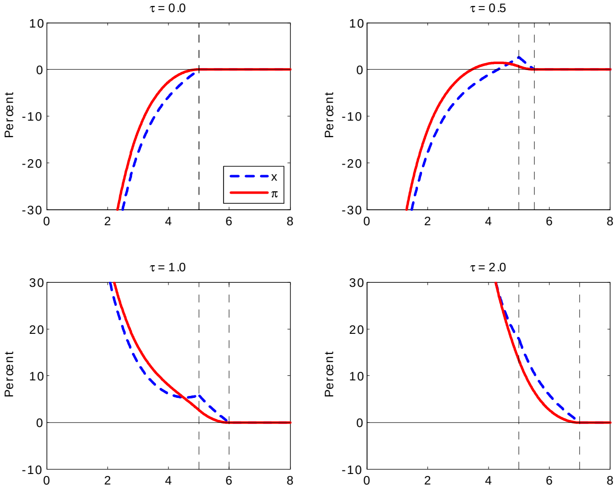
Magical multipliers



- Backward-explosive solutions+big π dynamics, $\partial x_t/\partial g_t$ is big
- Without big inflation dynamics ...$(x_t + g_t)$... $\partial x_t/\partial g_t = -1$

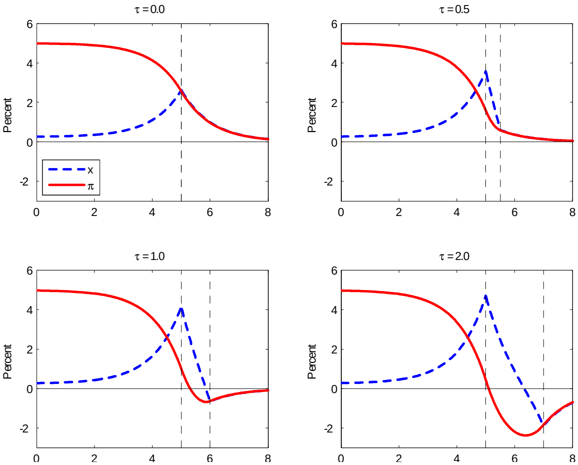
Low rate promise – standard equilibrium

- Interest rate stays at zero for time τ after the trap ends



- Far away promises have huge effects – backward explosive solution

Low rate promise – backwards-stable



- Faraway promises have little current effects.

Werning's equilibrium selection

Why $\pi_T = 0$? Answer: expectations of an equilibrium-selection policy, *apart from* interest rate policy

For $t \geq T$ the natural rate is positive, $r(t) = \bar{r} > 0$, so that, as mentioned above, the ideal outcome $(\pi(t), x(t)) = (0, 0)$ is attainable. I assume that the central bank can guarantee this outcome so that $(\pi(t), x(t)) = (0, 0)$ for $t \geq T$.[7] Taking this as given, at all earlier dates $t < T$ the central bank will find it optimal to set the nominal interest rate to zero. The resulting no-commitment outcome is then uniquely determined by the ODEs (1a)–(1b) with $i(t) = 0$ for $t \leq T$ and the boundary condition $(\pi(T), x(T)) = (0, 0)$.

This situation is depicted in Figure 1 which shows the dynamical system (1a)–(1b) with $i(t) = 0$ and depicts a path leading to $(0, 0)$ precisely at $t = T$. Output and inflation are both

[6] In this section, I proceed informally. With continuous time, a formal study of the no-commitment case requires a dynamic game with commitment over vanishingly small intervals.

[7] Although this seems like a natural assumption, it presumes that the central bank somehow overcomes the indeterminacy of equilibria that plagues these models. A few ideas have been advanced to accomplish this, such as adhering to a Taylor rule with appropriate coefficients, or the fiscal theory of the price level. However, both assume commitment on and off the equilibrium path. Although this issue is interesting, it seem completely separate from the zero lower bound. Thus, supposing that $(\pi(t), x(t)) = (0, 0)$ can be guaranteed for $t \geq T$ allows us to focus on the interaction between no commitment and a liquidity trap scenario.

Taylor rule

- Why $\pi_T = 0$?
- NK: *Two* Fed policies, "interest rate policy" i_t^* and "equilibrium selection policy" to pick one π_t^* from $\{\pi_t\}$ consistent with i_t^*.
- Taylor form of selection. Fed *also* specifies π_t^* from $\{\pi_t\}$, then adds

$$i_t = i_t^* + \phi_\pi(\pi_t - \pi_t^*).$$

  $\|\phi_\pi\| > 1+$ "no explosive solutions" $=$ select π_t^*

- The same as "Wicksellian" (optimal) "stochastic intercept" "temporary deviations" policy

$$\begin{aligned} i_t - i_t^* &= \phi_\pi\left(\pi_t - \pi_t^*\right) \\ i_t &= (i_t^* - \phi_\pi\pi_t^*) + \phi_\pi\pi_t \\ i_t &= \bar{\imath}_t + \phi_\pi\pi_t. \end{aligned}$$

- $\rightarrow$Expectations about equilibrium-selection policy/stochastic intercept/Wicksellian response, *not* about expected interest rates, drive the whole result.

Taylor rule

- Equilibrium selection policy

$$i_t = i_t^* + \phi_\pi(\pi_t - \pi_t^*).$$

- But do people really have these "expectations about equilibrium selection policy?"
- Let's look! Also "what if people expect a pure Taylor rule with no accommodation $\bar{\imath}_t$ for end-of-trap glidepath?"

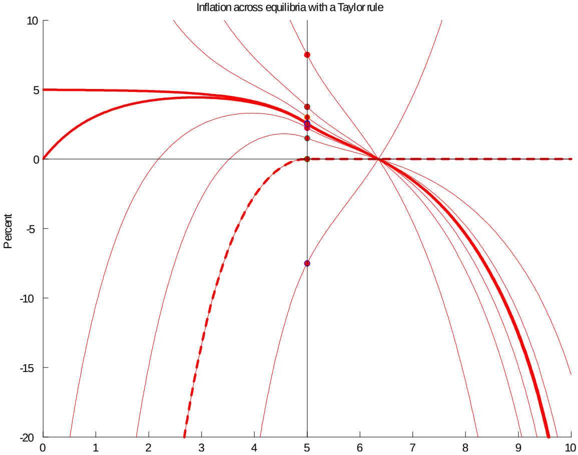
$$t > T: \; i_t = r + \phi_\pi \pi_t. \leftrightarrow \quad i_t^* = r, \pi_T^* = 0, t > T$$

- Continuous time: needs partial adjustment rule

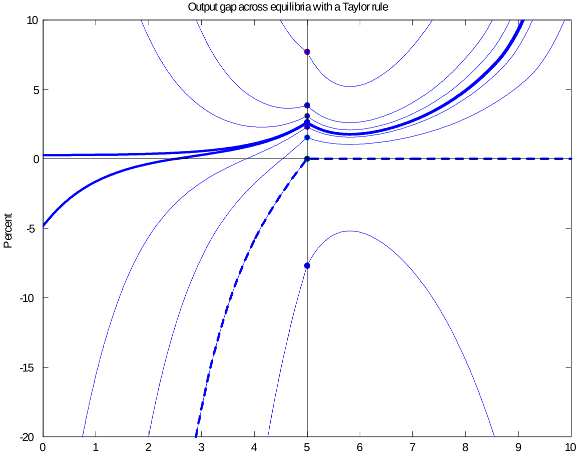
$$\frac{di_t}{dt} = \left\{ \begin{array}{cc} \theta\left[\phi_\pi \pi_t - (i_t - r)\right] & \text{if } i_t > 0 \\ \max\left\{\theta\left[\phi_\pi \pi_t - (i_t - r)\right], 0\right\} & \text{if } i_t = 0 \end{array} \right\}.$$

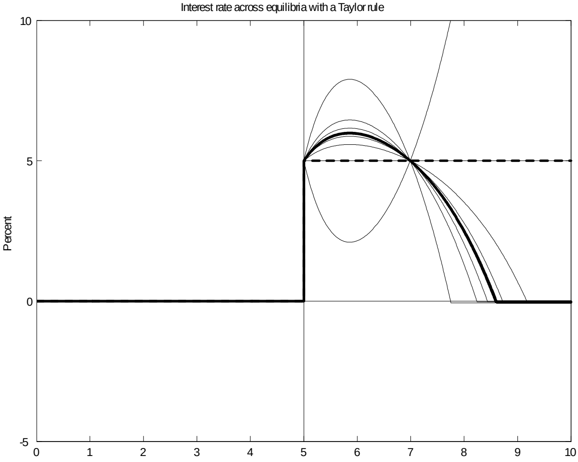
- No change for $t < T$. Different expectations for $t > T$ select $t < T$ equilibrium.

Taylor rule and the standard solution



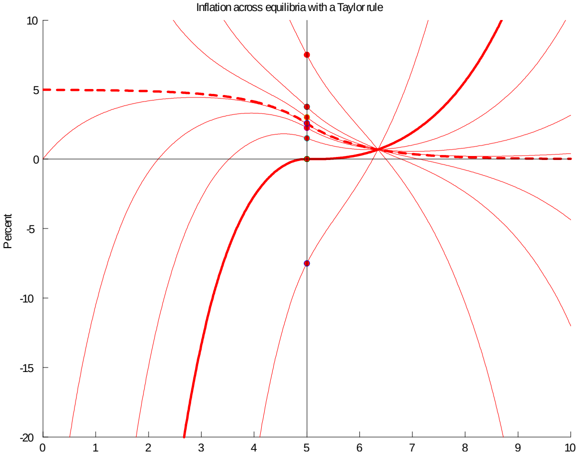
Taylor rule and the standard solution



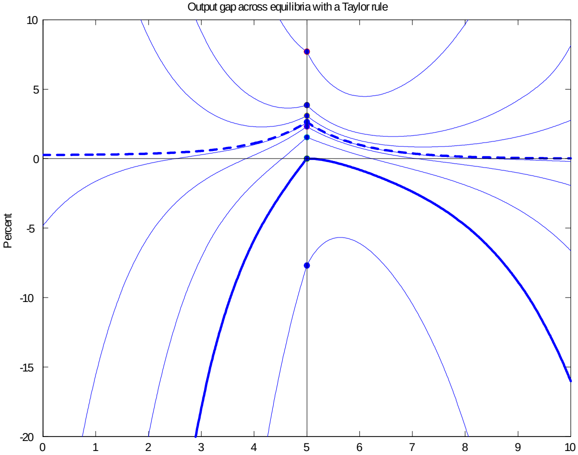


- Not: "if $\pi_T > 0$, Fed tightens too much, lowers inflation too fast"
- Yes: "if $\pi_T > 0$ people expect the Fed to explode the economy." *Or those equilibria are not ruled out.*

A Taylor rule could select the glidepath too



A Taylor rule could select the glidepath too



- The issue *is* expectations of a "equilibrium selection" policy.

Which equilibrium I

- Central assumption driving NK result: Expectations of the Fed's *equilibrium selection policy*, not *interest rate* policy.
- Does this selection even work? Why rule out non-local equilibria (JPE 2011)?
- Do people really believe this is what the Fed does?
    1. We never observe $\pi \neq \pi^*$ so cannot learn ϕ_π.
    2. The Fed loudly says it stabilizes $\|\lambda\| < 0$, not destabilizes $\|\lambda\| > 0$.
    3. Why do people believe the Fed would not allow a glidepath?
       Werning: $i_T^* = r$, $\pi_T^* = 0$ from lack of precommitment.
       Me: But $i_t - i_t^* = \phi_\pi(\pi_t - \pi_t^*)$ takes a *huge* precommitment.
    4. Is there really any such thing as "equilibrium selection policy?"

Which equilibrium II/Save the model

- Which equilibrium?
  1. ~~Expectations that the Fed will explode, has "equilibrium selection policy," insists on no glide path.~~
  2. Fiscal: Jump to negative inflation means a huge transfer to bondholders. (No-jump equilibrium has zero fiscal implications.) Inflation target is a *fiscal* promise, constraint on *Treasury*.
  3. Philosophical? No backward explosions, smooth frictionless limit?
  4. Data: account for stagnation? Magic in 1930, 1950, 1975?
- Goal: *Save* the NK model (forward looking, microfounded).
  1. Builds small, interesting nominal distortions on top of larger real models.
  2. Gets rid of the magic.
  3. Alas, if you like magic.
- NK central problem: Never took seriously nominal indeterminacy with interest rate targets