The Peril of the Inflation Exit Condition

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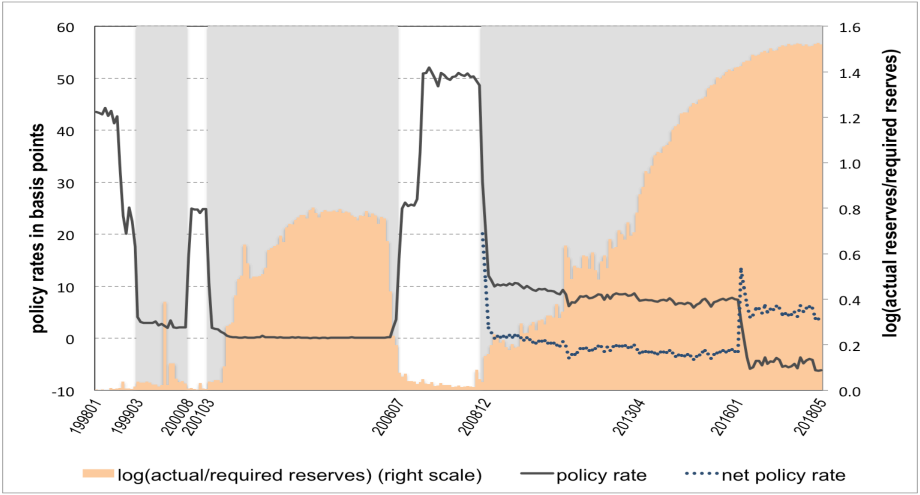
Policy Rates and Reserves, Japan, Jan. 1998 - May 2018



- net policy rate = policy rate - IOR.

Takeaways

- Two monetary policy regimes:
  - **P** (where the net rate > 0 and excess reserves ≈ 0),
  - **Z** (where the net rate ≈ 0).
- Three **Z** spells
  - Spell 1: March 1999-July 2000 (17 months), exit in August 2000,
  - Spell 2: March 2001-June 2006 (64 months), exit in July 2006,
  - Spell 3: Dec. 2008 onward.
- Not all **Z** spells are alike.
  - Spell 1 and 2: IOR $= 0$ in both. Excess reserves ≈ 0 in Spell 1.
  - Spell 2 and 3: excess reserve dynamics different.

Two Findings about Spell 2 (March 2001 - June 2006)

- (the QE effect) Measures of excess reserves have positive effects on output and inflation (Honda *et. al.* (2007), Honda (2014), and others).
- (*Policy-induced* exits can be expansionary) Exiting from Spell 2 one month earlier, in June 2006, would have been *expansionary* (a regime-switching SVAR evidence in Hayashi and Koeda ("Exiting from QE", 2018)).

references IR

Plan for the Rest of My Talk

- Executive summary of the regime-switching SVAR (4 slides).
- Evidence for expansionary exits (1 slide).
- Three examples of expansionary exits:
  1) active monetary policy (6 slides),
  2) active monetary policy with one-period information lag (1 slide),
  3) passive monetary policy with predetermined inflation (3 slides).

Only One Type of **Z**

- Assume
  (a) Spell 1 was a historical aberration.
  (b) Otherwise all **Z**'s are like Spell 2 (so no anticipation of QQE).
  (c) No IOR. No need to distinguish between the policy rate and the net policy rate.

- Taken together, if s_t denotes the monetary policy regime,

$$\begin{cases} r_t > 0 \text{ and } m_t = 0 & \text{if } s_t = \mathbf{P}, \\ r_t = 0 \text{ and } m_t > 0 & \text{if } s_t = \mathbf{Z}, \end{cases}$$

where $r \equiv$ policy rate, $m \equiv \log\left(\frac{\text{actual reserves}}{\text{required reserves}}\right)$.

Dynamics under **P** and **Z**

- Additional notation: $p \equiv$ monthly inflation rate, $x \equiv$ output gap.
- The SVAR is about $(s_t, p_t, x_t, r_t, m_t)$.
  - Switches between $(\mathbf{P}, p_t, x_t, r_t, 0)$ and $(\mathbf{Z}, p_t, x_t, 0, m_t)$.
- (super-standard) Dynamics under $s_t = \mathbf{P}$ is block-recursive:

$$\begin{cases} p = \text{const., lagged } p, \text{ lagged } x, \text{ lagged } r \quad + \text{ error}, \\ x = \text{const., lagged } p, \text{ lagged } x, \text{ lagged } r \quad + \text{ error}, \\ r = \underbrace{\text{const., } \pi, \ x \ + \ v_r}_{\textbf{"Taylor Rate"}}, \end{cases}$$

where $\pi_t \equiv \frac{1}{12}(p_t + \cdots + p_{t-11})$ is the *year-on-year inflation rate*.

- Dynamics under **Z**: Just replace "r" by "m" and "v_r" by "v_s".
- The reduced-form coefficients in the p and x equations can differ across regimes.

What Triggers Regime Changes?

- The usual formulation:

$$\text{(ZLB)} \qquad s_t = \begin{cases} \mathbf{P} & \text{if Taylor rate} > 0, \\ \mathbf{Z} & \text{otherwise.} \end{cases}$$

- Inappropriate for Japan thanks to BOJ's inflation commitment.
  - (April 1999) "(The Bank of Japan will) continue to supply ample funds until the deflationary concern is dispelled." (then BOJ governor Hayami)
  - (October 2003) "The Bank of Japan is currently committed to maintaining the quantitative easing policy until the CPI (excluding fresh food, on a nationwide basis) registers stably a zero percent or an increase year on year." (BOJ release)
  - (December 2016) "The Bank will continue with 'Quantitative and Qualitative Monetary Easing (QQE) with Yield Curve Control,' aiming to achieve the price stability target of 2 percent, as long as it is necessary for maintaining that target in a stable manner. It will continue expanding the monetary base until the year-on-year rate of increase in the observed CPI (all items less fresh food) exceeds 2 percent and stays above the target in a stable manner."

Regime Evolution with the Exit Condition

- The inflation exit condition means s_t evolves recursively. Replace the ZLB by

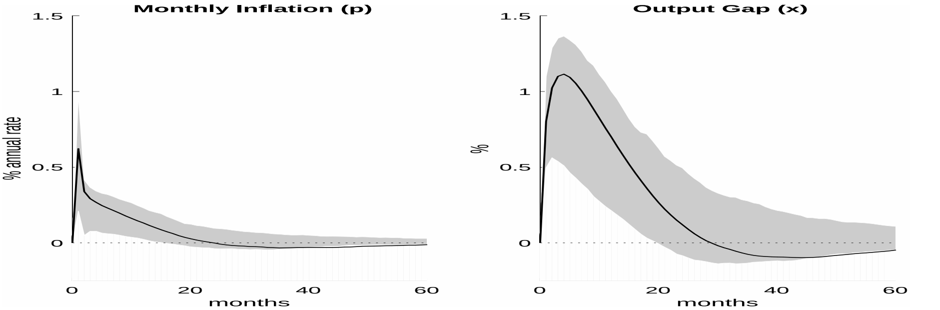
$$\begin{cases} \text{If } \; s_{t-1} = \mathbf{P}, \quad s_t = \begin{cases} \mathbf{P} & \text{if } \; \text{Taylor rate} > 0, \\ \mathbf{Z} & \text{otherwise.} \end{cases} \\ \\ \text{If } \; s_{t-1} = \mathbf{Z}, \quad s_t = \begin{cases} \mathbf{P} & \text{if } \; \text{Taylor rate} > 0 \text{ and } \; \pi_t \geq \underbrace{v_t}_{\text{“\textbf{threshold inflation}”}}, \\ \mathbf{Z} & \text{otherwise.} \end{cases} \end{cases} \tag{1}$$

- The central bank:
  - observes (p_t, x_t) and hence π_t.
  - draws three shocks (v_{rt}, v_{st}, v_t).
  - computes the Taylor rate and m_t.
  - picks s_t by (1). Then

$$(r_t, m_t) = \begin{cases} (\text{Taylor rate}, 0) & \text{if } s_t = \mathbf{P}, \\ (0, \text{value given by } m_t \text{ equation}) & \text{if } s_t = \mathbf{Z}. \end{cases}$$

toy model | absorbing state

The Effect of Exiting from QE in June 2006



Note: From Figure 4c of Hayashi and Koeda (2018). The 68% probability bands in shades.

two findings IR defined

Plan for the Rest of My Talk

- Executive summary of the Hayashi-Koeda regime-switching SVAR (4 slides).
- Evidence for expansionary exits (1 slide).
- Theoretical examples of expansionary exits:
  1) active monetary policy (6 slides),
  2) active monetary policy with one-period information lag (1 slide),
  3) passive monetary policy with predetermined inflation (3 slides).

A Toy Model: Fisher and Taylor

- Consists of Fisher and Taylor.

$$\text{(Fisher)} \qquad r_t = \rho + \mathrm{E}_t(\pi_{t+1}), \tag{2}$$

$$\text{(Taylor)} \qquad r_t = \begin{cases} \underbrace{\rho + \pi^* + \phi(\pi_t - \pi^*)}_{\text{Taylor rate}} & \text{if } s_t = \mathbf{P}, \\ 0 & \text{if } s_t = \mathbf{Z}, \end{cases} \tag{3}$$

- The evolution of s_t is (1) with Taylor rate $= \rho + \pi^* + \phi(\pi_t - \pi^*)$.
- The target inflation rate π^* vs. the threshold inflation rate v_t.
- The endogenous variables are (s_t, π_t, r_t). Threshold inflation v_t is the only shock.

regime evolution

Example 1: $\phi > 1$ and (π, r) Simultaneously Determined

- The threshold inflation v_t is a two-state Markov chain. $v > \pi^*$.

v_{t-1} \ v_t	v (state 0)	π^* (state 1)
v (state 0)	q	$1-q$
π^* (state 1)	0	1

- Look for Markov equilibria:

$$(s_t, \pi_t, r_t) = \begin{cases} (s^{(0)}, \pi^{(0)}, r^{(0)}) & \text{in state 0, i.e., if } v_t = v \ \ (> \pi^*), \\ (s^{(1)}, \pi^{(1)}, r^{(1)}) & \text{in state 1, i.e., if } v_t = \pi^*. \end{cases}$$

- An exit time path for a sample path of $\{v_t\}$:

t	0	1	2	3	4	...
v_t	$\cdots$	$v \ \ (> \pi^*)$	$v \ \ (> \pi^*)$	π^*	π^*	...
s_t	**Z**	**Z**	**Z**	**P**	**P**	...
π_t	...	$-\frac{(\rho+\pi^*)}{q} + \pi^* \ (< 0)$	$-\frac{(\rho+\pi^*)}{q} + \pi^* \ (< 0)$	π^*	π^*	...
r_t	...	0	0	$\rho + \pi^*$	$\rho + \pi^*$	...

In the Absorbing State

- In state 1 ($v_t = \pi^*$), the Fisher equation becomes:

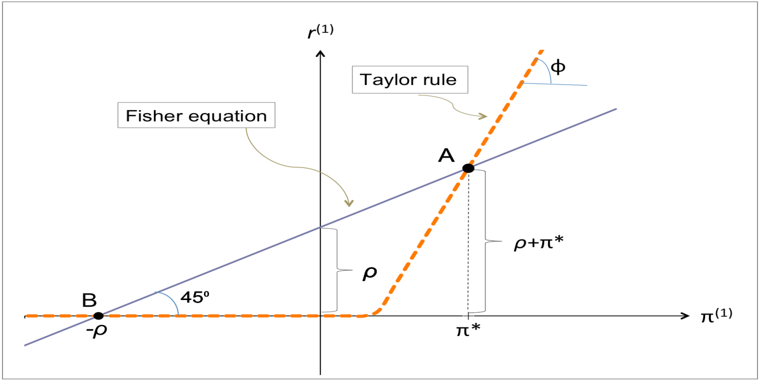
$$\text{(Fisher)} \qquad r^{(1)} = \rho + \pi^{(1)}. \tag{4}$$

- Suppose $s_{t-1} = \mathbf{P}$. $t \geq 4$ in the above table.
- The Taylor rule becomes

$$\text{(Taylor)} \qquad r^{(1)} = \begin{cases} \underbrace{\rho + \pi^* + \phi(\pi^{(1)} - \pi^*)}_{\text{Taylor rate}} & \text{if Taylor rate} > 0, \\ 0 & \text{otherwise.} \end{cases} \tag{5}$$

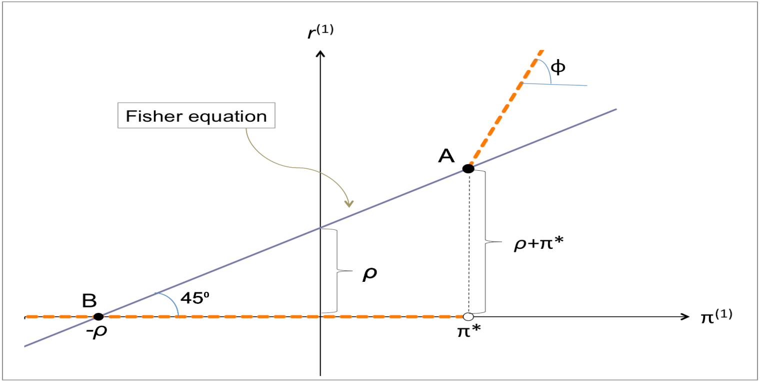
regime evolution

The Peril of the Taylor Rule



- Two equilibria under active monetary policy ($\phi > 1$) (Benhabib *et. al.* (2001)).
- Pick point A: $(\pi^{(1)}, r^{(1)}) = (\pi^*, \rho + \pi^*)$. The targted-inflation equilibrium.
- Given $s_{t-1} = \mathbf{P}$, $s_t = \mathbf{P}$.

Check the Transition



- The Taylor rule becomes

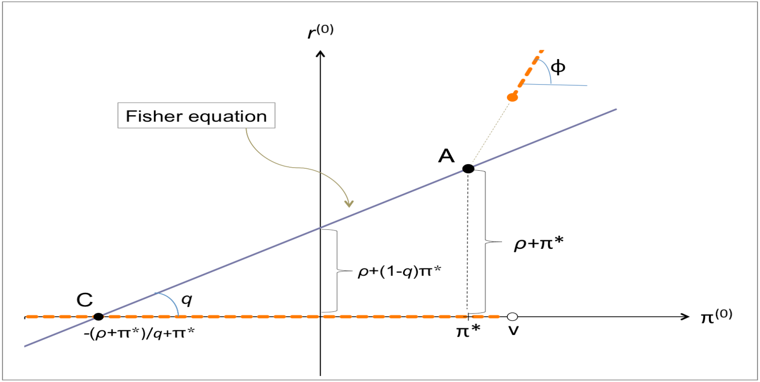
$$(\text{Taylor}) \qquad r^{(1)} = \begin{cases} \underbrace{\rho + \pi^* + \phi(\pi^{(1)} - \pi^*)}_{\text{Taylor rate}} & \text{if Taylor rate} > 0 \text{ and } \pi^{(1)} > \pi^*, \\ 0 & \text{otherwise.} \end{cases} \qquad (6)$$

The Exit Condition Eliminates the Good Equilibrium

- State 0 ($v_t = v > \pi^*$). Suppose $s_{t-1} = \mathbf{Z}$.

$$\text{(Fisher)} \qquad r^{(0)} = \rho + q\pi^{(0)} + (1-q)\pi^*. \tag{7}$$

$$\text{(Taylor)} \qquad r^{(0)} = \begin{cases} \underbrace{\rho + \pi^* + \phi(\pi^{(0)} - \pi^*)}_{\text{Taylor rate}} & \text{if Taylor rate} > 0 \text{ and } \pi^{(0)} \geq v, \\ 0 & \text{otherwise.} \end{cases} \tag{8}$$



Example 2: $\phi > 1$ and π is predetermined

- One-period information lag and predetermined inflation.

t	0	1	2	3	4	...
v_t	...	$v \ \ (> \pi^*)$	$v \ \ (> \pi^*)$	π^*	π^*	...
s_t	**Z**	**Z**	**Z**	**Z**	**P**	...
π_t	...	$-\frac{(\rho+\pi^*)}{q} + \pi^*$	$-\frac{(\rho+\pi^*)}{q} + \pi^*$	$-\frac{(\rho+\pi^*)}{q} + \pi^*$	π^*	...
r_t	...	0	0	0	$\rho + \pi^*$	...
$\mathrm{E}_t(\pi_{t+1})$	...	$-\frac{(\rho+\pi^*)}{q} + \pi^*$	$-\frac{(\rho+\pi^*)}{q} + \pi^*$	π^*	π^*	...

Example 3: $0 < \phi < 1$ and Predetermined Inflation

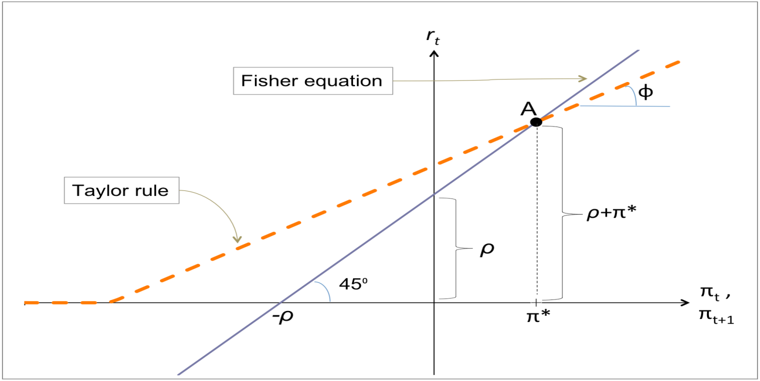
- Suggested by Stephanie Schmitt-Grohe. π is predetermined.

$$\text{(Fisher)} \qquad r_t = \rho + \pi_{t+1}.$$

- The Taylor rule is the same as in Example 1.
- Taylor & Fisher provides a mapping from (s_{t-1}, π_t) to (s_t, π_{t+1}).
  - Taylor: $(s_{t-1}, \pi_t) \mapsto (s_t, r_t)$, Fisher: $r_t \mapsto \pi_{t+1}$.
- $\{v_t\}$ doesn't have to be a Markov chain with absorbing states.
- The exit path for a sample path of $\{v_t\}$:

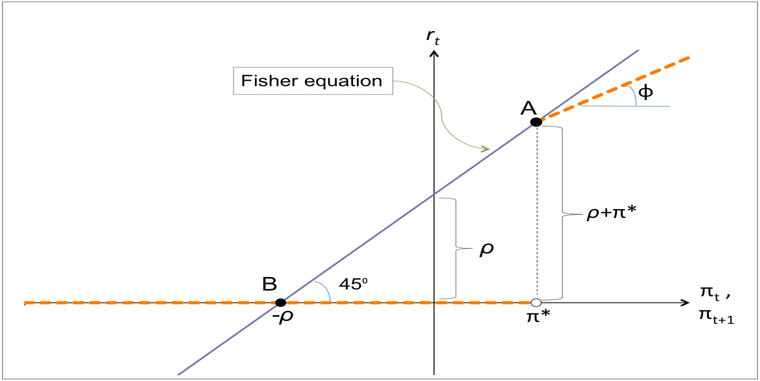
t	0	1	2	3	4	5	...
v_t	...	π^*	π^*	v_3 $(\leq -\rho)$	v_4	v_5	...
s_t	**Z**	**Z**	**Z**	**P**	**P**	**P**	...

Without the Exit Condition...



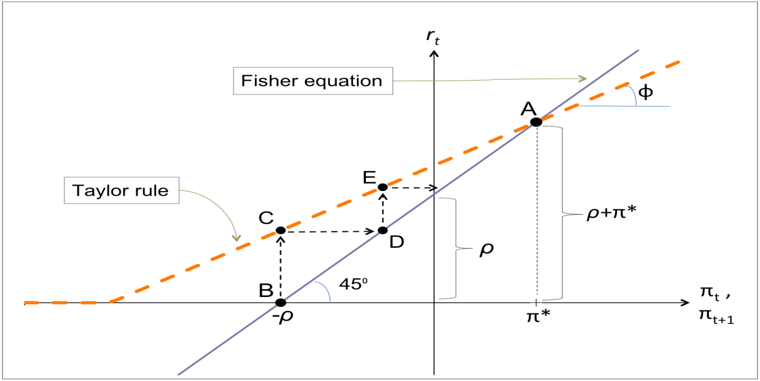
- Only one steady state. It is the targeted-inflation equilibrium. It is stable.

The Exit Condition *Introduces* the Bad Equilibrium



- Taylor rate is positive. Nevertheless regime **Z** is chosen.

What Happens if Suspend the Exit Condition?



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two findings

Appendix: (Nonlinear) IR Defined

- The IR to an exit in t:

$$\mathrm{E}\Big(y_{t+k}\,\Big|\,\underbrace{s_t = \mathbf{P},\ \underbrace{(p_t, x_t, 0, 0)}_{(p,\,x,\,r,\,m)\text{ for date }t}\ , \dots}_{\text{alternative history}}\Big) - \mathrm{E}\Big(y_{t+k}\,\Big|\,\underbrace{s_t = \mathbf{Z},\ \underbrace{(p_t, x_t, 0, m_t)}_{(p,\,x,\,r,\,m)\text{ for date }t}\ , \dots}_{\text{baseline history}}\Big), \tag{9}$$

- This can be decomposed into two:

$$\begin{aligned}(9) = \ &\Big[\underbrace{\mathrm{E}\big(y_{t+k}\,|\,s_t = \mathbf{P}, (p_t, x_t, 0, 0), \dots\big) - \mathrm{E}\big(y_{t+k}\,|\,s_t = \mathbf{Z}, (p_t, x_t, 0, 0), \dots\big)}_{\text{transitional effect of an exit from }\mathbf{Z}\text{ to }\mathbf{P}}\Big] \\ &- \Big[\underbrace{\mathrm{E}\big(y_{t+k}\,|\,s_t = \mathbf{Z}, (p_t, x_t, 0, m_t), \dots\big) - \mathrm{E}\big(y_{t+k}\,|\,s_t = \mathbf{Z}, (p_t, x_t, 0, 0), \dots\big)}_{\text{the QE effect}}\Big].\end{aligned} \tag{10}$$

back to IR graph