Central banks going long

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Role of long interest rates: targets

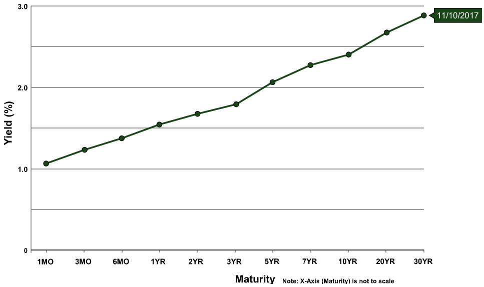
Yellen (2017) “For this reason, the Committee turned to asset purchases to help make up for the shortfall by putting additional downward pressure on longer-term interest rates.”

Role of long interest rates: goals

Federal Reserve Act of 1913: "... to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates."

Role of long interest rates: tools

Central banks issue reserves and make loans. Choose maturity of these. Control the interest rate at that maturity. Overnight, but 30 days, 90 days, ...



This paper

1. Three historical episodes where long-term interest rates were central to monetary policy:
   - United States, 1943-51
   - United Kingdom 1959-70
   - Japan, 2016-...

2. Recast the problem of inflation determination in continuous time using diffusions for uncertainty, and integrate with models of yield curve.

Continuous-time inflation

Real economy

- Representative agent solves:
$$\max_{\{\{c_{t,j}\},l_t\}} \mathbb{E}_0 \int_0^\infty \beta^t \left(\frac{c_t^{1-\gamma}}{1-\gamma} - \frac{l_t^{1+\psi}}{1+\psi} \right) dt$$
$$c_t = \left(\int_0^1 c_{t,j}^{\frac{\mu}{\mu-1}} dj \right)^{\frac{\mu-1}{\mu}},$$
$$d(b_t + v_t) = \left(i_t - \frac{dp_t}{p_t} \right) v_t + r_t b_t + (w_t l_t + z_t - c_t) dt.$$
- Continuum of monopolistic firms operate a technology $y_{t,j} = a_t l_{t,j}$.
- Market clearing: $l_t = \int l_{t,j} dj$, $c_{t,j} = y_{t,j}$, $b_t = v_t = 0$.

Equilibrium

- Output (and marginal utility $m_t = \beta y_t^{\gamma}$):

$$y_t^{\gamma+\psi} = \mu a_t^{1+\gamma}$$

- Classical dichotomy:

$$\frac{dy_t}{y_t} = g_t d_t + \sigma_y dz_t^y \qquad g_t = -\kappa_g (g_t - \bar{g}) dt + \sigma_g dz_t^g$$

Lemma

In the real equilibrium, the real interest rate follows:

$$dr_t = -\kappa_y (r_t - \bar{r}) d_t + \gamma \sigma_g dz_t^g$$

where $\bar{r} = \gamma \bar{g} - \ln \beta - 0.5\gamma(\gamma + 1)\sigma_y^2$.

The central bank

- Take on deposits (reserves) of maturity s, promise: $I_t^{(s)}$:

$$\mathbb{E}_t\left(\frac{m_{t+s}I_t^{(s)}}{p_{t+s}}\right) = \frac{m_t}{p_t} \qquad \mathbb{E}_t\left(\frac{d(m_t/p_t)}{(m_t/p_t)}\right) = -i_t dt$$

- Independent central bank. Hall-Reis theorem applies.

- Feedback rule:

$$d(i_t - x_t) = -\rho(i_t - x_t)dt + \phi\left(\frac{dp_t}{p_t} - \pi^* dt\right)$$

where x_t follows a Markov process with long-run mean $\bar{x}$.

The equilibrium

Definition

A bounded homoskedastic Markov equilibrium is a function for expected inflation $\bar{\pi}(r, x) : \Re^2 \to \Re$ and three constants, $\alpha_y, \alpha_g, \alpha_r$ such that:

$$\frac{dp_t}{p_t} = \bar{\pi}(r_t, x_t)dt + \alpha_y \sigma_y dz_t^y + \alpha_g \sigma_g dz_t^g + \alpha_r \sigma_r dz_t^r,$$

given the path for dm_t and dr_t, the Euler equation for di_t and so that expected inflation satisfies:

$$\lim_{T \to \infty} \mathbb{E}_t \left(e^{-\epsilon(T-t)} \pi(r_T, x_T) \right) = 0$$

for any $\epsilon > 0$.

Equilibrium expected inflation

- Can write an ODE for expected inflation

$$\mathbb{E}_t(d(\bar{\pi}_t + \varepsilon_t - \pi^*)) + (\rho - \phi)\,\mathbb{E}_t(\bar{\pi}_t + \varepsilon_t - \pi^*)dt = -\phi\,\mathbb{E}_t(\varepsilon_t)dt$$

- As long as $\phi > \rho$

$$\bar{\pi}_t = \pi^* + \left(\frac{\rho}{\phi - \rho}\right)\varepsilon_t + \int_0^\infty \phi e^{-(\phi-\rho)s}\,\mathbb{E}_t(\varepsilon_{t+s} - \varepsilon_t)ds$$

- Taylor principle: make expected inflation explosive

Inflation and its target

- Deviations of inflation from target:

$$\varepsilon_t = (r_t + \pi^* - \alpha'\alpha - \gamma\sigma_y^2\alpha_y) - x_t$$

- If $\varepsilon_t = 0$ at all dates, then inflation will always be on target. Need omniscient, long-lived, and inflation-nutter central bank.

- Opposite case, x_t follows an exogenous process:

$$dx_t = -\kappa_x(x_t - \bar{x})d_t + \sigma_x dz_t^x$$

Expected inflation

$$\bar{\pi}(r_t, x_t) = \pi^* + \left(\frac{\rho}{\phi - \rho}\right)\left(\bar{r} + \pi^* - \alpha'\alpha - \gamma\sigma_y^2\alpha_y - \bar{x}\right)$$
$$+ \left(\frac{\rho - \kappa_g}{\kappa_g + \phi - \rho}\right)(r_t - \bar{r}) - \left(\frac{\rho - \kappa_x}{\kappa_x + \phi - \rho}\right)(x_t - \bar{x}).$$

1. First line: intercept. Need average real interest rate and inflation risk premia.

2. Second line: sensitivity to state of economy and to policy.

Sensitivity of inflation to shocks

$$
\begin{aligned}
\alpha_x &= -\frac{1}{\kappa_x + \phi - \rho} \\
\alpha_r &= \frac{\gamma}{\kappa_g + \phi - \rho} \\
\alpha_y &= 0
\end{aligned}
$$

- Higher nominal rates *lower* inflation.
- Shocks to output level that do not move real interest rates have no effect on inflation. Similarly, no sunspot nominal shocks and homoskedastic.

Equilibrium interest rates

Lemma

Define the yield on the bond as $i_t^{(s)} = \log(I_t^{(s)})/s$. *It is:*

$$i_t^{(s)} = \delta_0(s) + \delta_i(s) i_t + \delta_x(s) x_t$$

where $\delta_i(s) = (1 - e^{-\kappa_g s})(\kappa_g + \phi - \rho)/(\kappa_g \phi)$.

- Satisfy arbitrage relation or infinite/zero reserves.
- For large maturities, s is large, so $\delta_i(s)$ small. Lumpy and infrequent policy decisions on long rate will lead to intense speculation on short rates.
- Affine class, easy to include time-varying risk premium (uncertainty and news shocks), connect to data, or include effect of QE on long rates.

The United States pre accord: 1942-1951

Fed after the Great Depression

- Goal of monetary policy in war: answer to Treasury, keep bond prices low.
- April 1942 announcement of policy regime: Fed stood ready to buy and sell 90-day Treasury bills at a fixed rate of 3/8%.
- Raised T-bill rate against inflation. July of 1947; by end of 1948: 1 and 1/8%.

1949-51: The Fed versus the Treasury

- Korean War and higher r_t.

- *"As long as the Federal Reserve is required to buy government securities at the will of the market for the purpose of defending a fixed pattern of interest rates established by the Treasury, it must stand ready to create new bank reserves in unlimited amount. This policy makes the entire banking system, through the action of the Federal Reserve System, an engine of inflation. (U.S. Congress 1951, p. 158)".*

- Treasury-Fed accord of March 4, 1951: *"Few episodes in American monetary history have attracted so much attention in the halls of Congress and in academic quarters, alike."* Friedman and Schwartz.

Fed going long

- 1942 regime: explicitly announced ceiling of 2.5% for the 10-year yield.

- 1942-45: not binding.

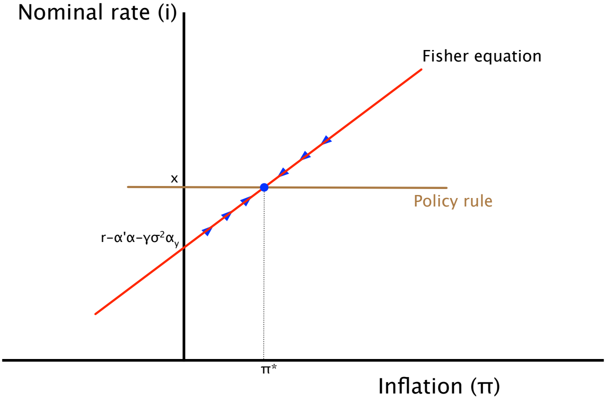
- 1945-47: yield reached 2.37% in November 1947, December 2.45%, Fed's portfolio maturity increased . Still, October 16, 1947: *"We can assure you that these actions will not affect the maintenance of the 2 1/2 percent rate for the outstanding long-term government bonds."*

- Korean War: pressure, yield curve flatter, Truman worried about mortgage rates. Fed only abandons ceiling in 1953, after which "bills only".

A hard peg

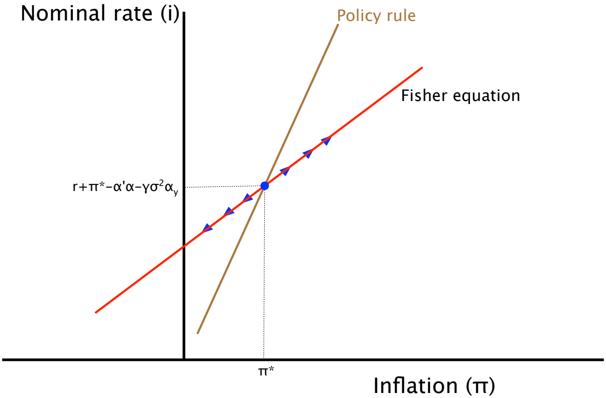
The modified Fisher equation with $\phi = 0$ and constant x_t:

$$\bar{\pi}_t = \bar{x} - r_t + \alpha'\alpha + \gamma\sigma_y^2\alpha_y$$



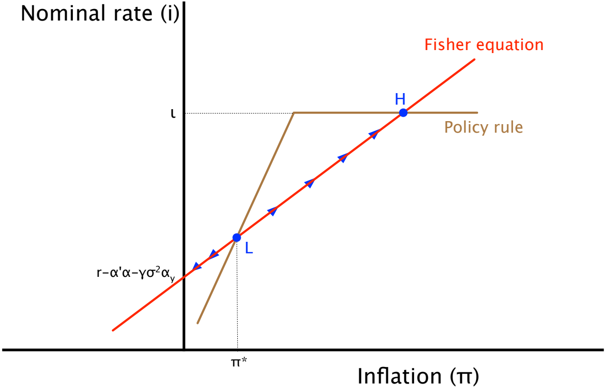
Feedback rule

Hard peg only lasted for 5 years: maybe just small ρ and ϕ.



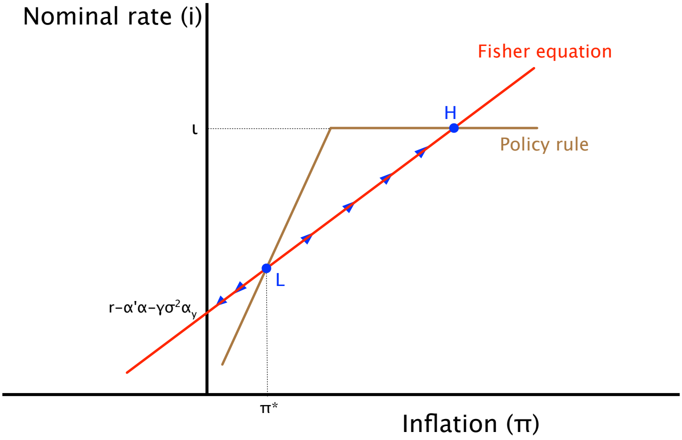
Feedback rule

Ceiling $i_t^{(s)} \leq \iota$. Follow feedback rule unless violate ceiling, then interest rate unchanged.



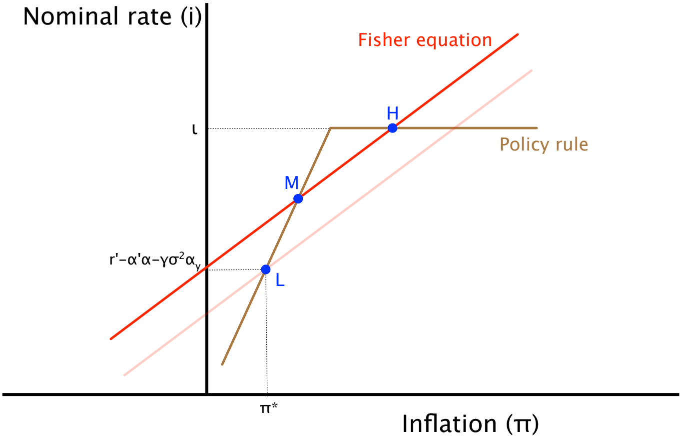
Model and history

Until 1950, around L, move x slightly .



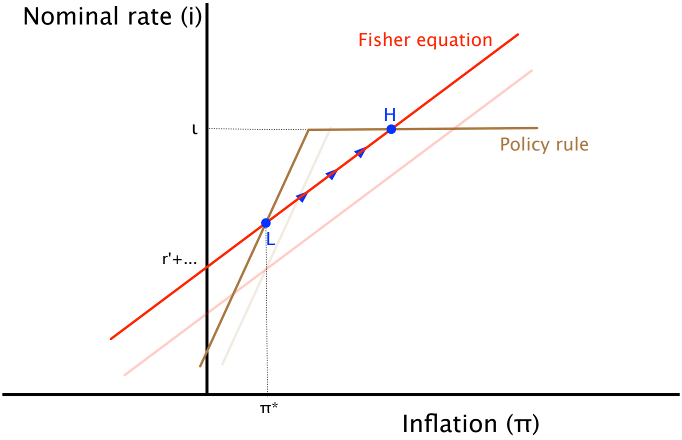
Model and history

Korea war, r_t rises, M equilibrium.



Model and history

Raise rates, drop peg, back to L, but fear of escapes.



The Radcliffe commission and UK monetary policy in the 1960s

Radcliffe report, August 1959

"to inquire into Britain's monetary and credit mechanism and to make recommendations".

Committee on the Working
of the Monetary System

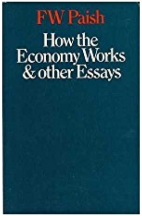
REPORT

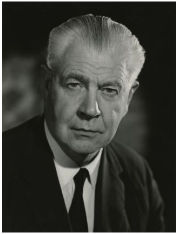
Presented to Parliament by the Chancellor of the Exchequer
by Command of Her Majesty
August 1959

LONDON
HER MAJESTY'S STATIONERY OFFICE
Reprinted 1964
mnd. 827 PRICE £1 0*s*. 0*d*. NET

UK monetary policy in 1950s

- Policy goal: lower unemployment. Policy tool: fiscal policy and AD management. Role of monetary policy: manage international reserves via bank rate. Criticized for neglecting "cheap money" and investment.
- Ceiling on 10-year rate of 2.5%, by refusing to sell bonds at lower price. Increase in bank rate come with maturity of public debt falling, criticised.
- Intellectual debate on role of monetary policy: liquidity not money, credit policies, interest rates.






The Radcliffe report's view

1. Monetary policy has many goals.

2. Use international reserves to dampen exchange rate volatility.

3. Money does not matter, "liquidity".

4. Monetary policy should actively work through credit controls.

5. *"...must have and must consciously exercise a positive policy about interest rates, long as well as short, and about the relationship between them."* Setting interest rates, let markets determine maturities. Interest rates have little effect on AD or on money.

The Bank of England going long

- Short rate to stabilize exchange rate. Estimate the "right level" for long interest rates and use issuance of bonds of different maturities, credit controls, bank regulation, bank rate to achieve steady demand for government bonds.

- Policy: peg $i_t^{(s)}$ around an exogenous ι_t. Similar to analysis of indeterminacy.

- Alternative:

$$d(i_t^{(s)} - \iota_t) = -\rho(i_t^{(s)} - \iota_t)dt + \phi_\iota \left(\frac{dp_t}{p_t} - \pi^* dt \right)$$

with a small ϕ_ι and a large extent of smoothing ρ.

Result

Lemma

The policy rule for long-term interest rates in equation leads to inflation dynamics as in the proposition with

$$\phi = \frac{\phi_\iota}{\delta_i(s)}$$

and

$$x_t = \frac{\iota_t - \delta_0(s)}{\delta_i(s) + \delta_x(s)}$$

- If s small, $\delta_0(s)$ and $\delta_x(s)$ are close to zero, $\delta_i(s)$ is close to 1, so result from phase diagrams approximately apply.
- Going long, large s, small $\delta_i(s)$

Difficulties with going long

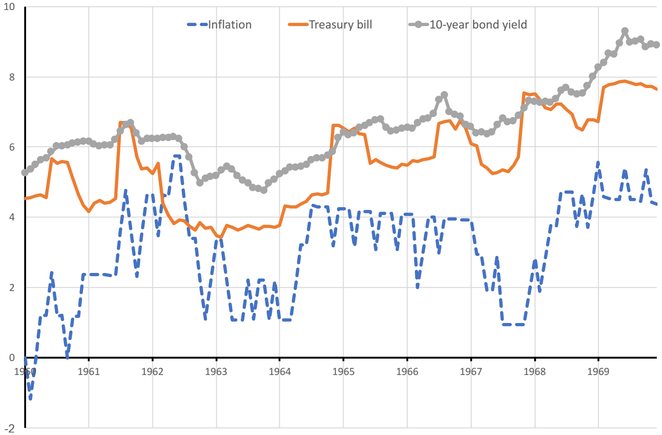
1. $\phi_\iota > \delta_i(s)\rho$ for determinacy. Less stringent condition, Taylor principle far from applying.

2. Precise target of $\bar{x}$, requires target for $\bar{\iota}$ to target $\bar{x} = \frac{\bar{\iota}-\delta_0}{\delta_i+\delta_x}$.

3. Keeping ε_t close to zero hard, too low ι_t from debt management conflicts, exogenous shocks large if $\delta_i(s) + \delta_x(s) < 1$.

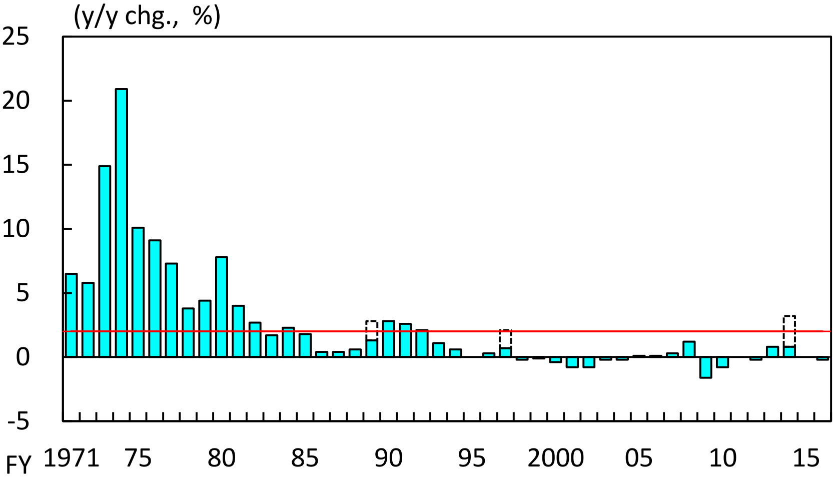
The UK in the 1960s

UK struggled, interest rates crept up, inflation rose

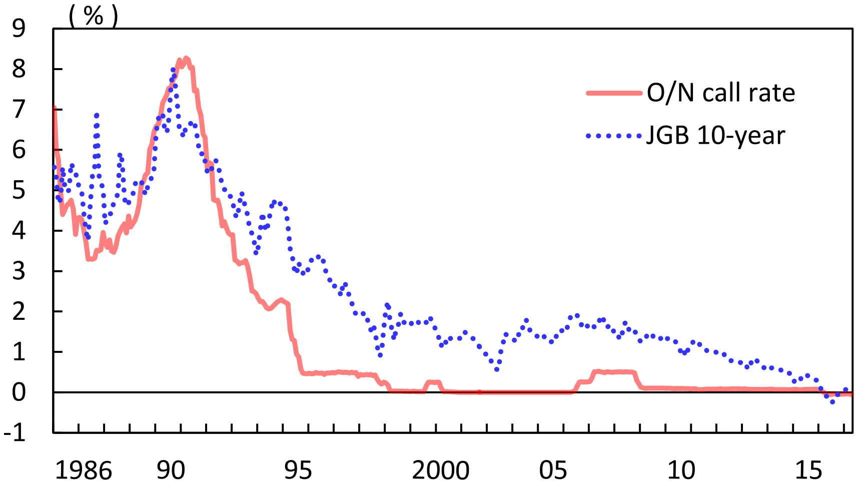


The Bank of Japan's yield curve control, 2016-...

Core CPI

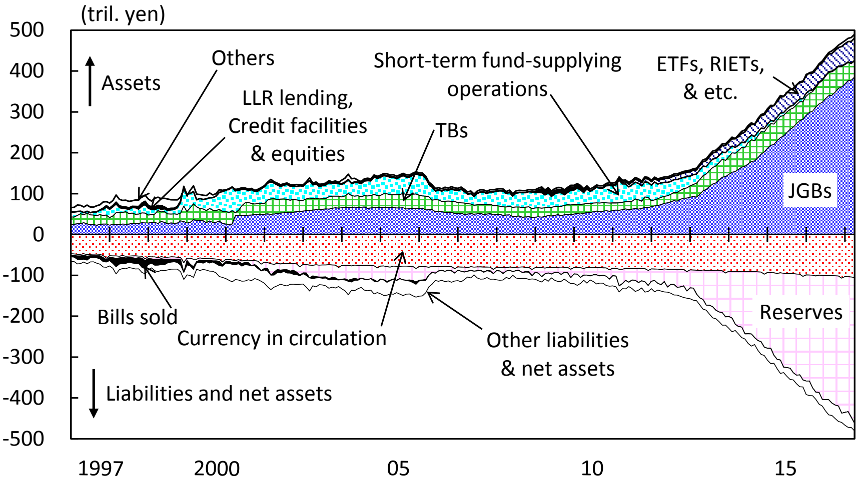


Nominal Interest Rates



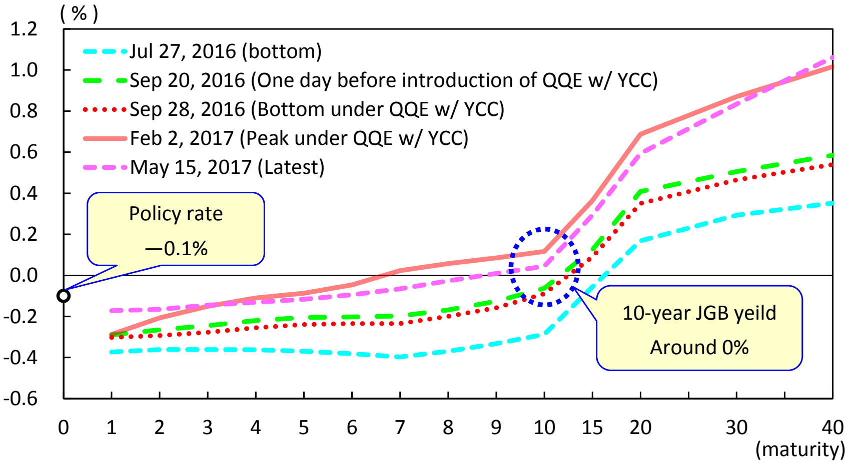
Source: Shiratsuka, 2017.

BOJ’s Balance Sheet



Source: Shiratsuka, 2017.

Yield Curve Control



Source: Shiratsuka, 2017.

The Bank of Japan going long

- Precise targets for two interest rates, not ceilings.

- Target slope of the yield curve:

$$d(i_t^{(s)} - i_t - \iota_t) = -\rho(i_t^{(s)} - i_t - \iota_t) + \phi_\iota \left(\frac{dp_t}{p_t} - \pi^* dt \right)$$

Lemma

The policy rule for the slope of the yield curve in equation leads to inflation dynamics as in proposition with

$$\phi = \phi_\iota / (\delta_i(s) - 1)$$

and

$$x_t = \frac{\iota_t - \delta_0(s)}{\delta_i(s) + \delta_x(s) - 1}.$$

Theory predictions

1. Now $\phi > \rho$ requires: $\phi_\iota < 0$.

2. The BoJ should commit to increasing its 10-year yield target by less than its overnight interest rate when inflation increases. Stimulating inflation requires steepening the yield curve.

3. Opposite of BoJ policy. Stimulative monetary policy is low short rates, and high long rates.

Performance so far

Consumer Prices

Note: Figures for the CPI are adjusted to exclude the estimated effects of changes in the consumption tax rate.

Conclusion

Conclusion

- Past decade, central banks went long by talking about long-term interest rates a lot more to evaluate and guide their policies.
- Historical case studies. Each used long-term interest rate differently. None very successful.
- Methodologically: link monetary policy and inflation analysis to yield curve models by having shocks follow continuous-time diffusions.