Topic 2
The Baseline New Keynesian Model, Monetary Policy, and the Liquidity Trap: Part 2

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Outline

- *Part 1*
  Household consumption, labor supply and saving decisions, and money demand
  Firm labor, capital and price setting decisions
  Monetary policy: Taylor rules
  Decentralized equilibrium: monetary non-neutrality and inefficient output fluctuations

- *Part 2*
  Loglinear model
  Aggregate demand, Inflation and the natural rate of interest
  The New Keynesian Phillips curve
  Monetary policy design in the basic NK model
  The liquidity trap

Loglinearization: Aggregate Demand

Let $x_t = \log X_t - \log X$, except for $r_t^n (\approx \log R_t^n)$, p_t and m_t which are in log levels
Let $\rho \equiv -\log \beta$, steady state net real interest rate $\approx \beta^{-1} - 1$
Loglinearize around the steady state ($A_t = A$) with zero inflation ($\frac{P_t}{P_{t-1}} = 1$).

$$y_t = c_t \tag{1}$$

$$c_t = -\sigma \left[r_t^n - E_t \pi_{t+1} - \rho \right] + E_t \{ c_{t+1} \} \tag{2}$$

$$r_t^n - E_t \pi_{t+1} - \rho = E_t \left\{ (1-\nu)(mc_{t+1} + y_{t+1}) + \nu q_{t+1} - q_t \right\} \tag{3}$$

where $\pi_t = p_t - p_{t-1}$, $\nu = 1/[\alpha MC \frac{Y}{K} + 1]$, $\sigma = \frac{1}{\gamma}$, $Q = 1$, $z_{t+1} = mc_{t+1} + y_{t+1}$

Loglinearization: Aggregate Demand (con't)

Equation (3) can be rewritten as:

$$q_t = E_t\left[(1-\nu)(mc_{t+1}+y_{t+1})+\nu q_{t+1}-(r_t^n-E_t\pi_{t+1}-\rho)\right] \tag{4}$$

$$\tag{5}$$

$$= E_t\sum_{i=0}^{\infty}\nu^i\left[(1-\nu)(mc_{t+1+i}+y_{t+1+i})-(r_{t+i}^n-\pi_{t+1+i}-\rho)\right] \tag{6}$$

$\rightarrow$ Log price of capital equals the loglinearized expected discounted value of earnings.

- Note: In a model with variable capital, investment will depend positively on q_t.

Loglinearization: Aggregate Supply

Let $\widehat{\mu}_t = \mu_t - \mu^*$ (markup minus desired steady state markup)$\rightarrow$

$$y_t = a_t + (1-\alpha) l_t \tag{7}$$

$$a_t - \alpha l_t = \widehat{\mu}_t + \varphi l_t + \gamma c_t \text{ (with } \widehat{\mu}_t = -mc_t) \tag{8}$$

$$p_t = \theta p_{t-1} + (1-\theta) p_t^o \tag{9}$$

$$p_t^o = (1-\theta\beta) E_t \sum_{i=0}^{\infty} (\theta\beta)^i (mc_{t+i} + p_{t+i}) \tag{10}$$

$$= (1-\theta\beta)(mc_t + p_t) + \theta\beta E_t\{p_{t+1}^o\} \tag{11}$$

Given $mc_t = \log MC_t - logMC \rightarrow mc_t + p_t =$ log nominal marginal cost.

Loglinearization: Monetary Policy

In the zero inflation steady state $r^n = r = \rho$ (from the consumption euler equation).

Monetary Policy Rule

$$r_t^n = \rho + \phi_\pi \pi_t + \phi_y (y_t - y_t^*) + \upsilon_t \tag{12}$$

Money demand

$$m_t - p_t = k + \frac{\gamma}{\gamma_m} y_t - \eta r_t^n$$

with $k = \frac{1}{\gamma_m} \log a_m + \frac{\gamma}{\gamma_m} y, \eta = \frac{1}{\gamma_m (R^n - 1)}$

Note again: we can ignore money demand since the central bank just adjusts m_t to support its objective for r_t^n.

Loglinearization: Flexible Price Equilibrium

impose $\mu_t = \mu^* \rightarrow \widehat{\mu}_t = 0 \rightarrow (y_t^*, c_t^*, l_t^*, r_{t+1}^*)$ determined by

$$\begin{aligned} y_t^* &= c_t^* \\ c_t^* &= -\sigma \left[r_{t+1}^* - \rho \right] + E_t\{c_{t+1}^*\} \\ y_t^* &= a_t + (1-\alpha) l_t^* \\ a_t - \alpha l_t^* &= \varphi l_t^* + \gamma c_t^* \end{aligned}$$

given $y_t^* = c_t^* \rightarrow y_t^*, l_t^*$ jointly determined by

$$\begin{aligned} y_t^* &= a_t + (1-\alpha) l_t^* \\ a_t - \alpha l_t^* &= \varphi l_t^* + \gamma y_t^* \end{aligned}$$

with r_{t+1}^* given by

$$y_t^* = -\sigma \left[r_{t+1}^* - \rho \right] + E_t\{y_{t+1}^*\}$$

"IS/AS" Formulation

The above system can be collapsed into two equations: an IS curve that relates output demand inversely to the real interest rate and an aggregate supply curve that relates inflation to excess demand:

$$IS \quad : \quad y_t = -\sigma(r_t^n - E_t\pi_{t+1} - \rho) + E_t y_{t+1} \tag{13}$$

$$AS \quad : \quad \pi_t = \lambda(y_t - y_t^*) + \beta E_t \pi_{t+1} \tag{14}$$

with $\lambda = \frac{(1-\theta)(1-\beta\theta)}{\theta}\kappa$, and where $\kappa \equiv$ elasticity of mc_t w.r.t. y_t
$y_t^* = \frac{1+\varphi}{1+\varphi+(\gamma-1)(1-\alpha)} a_t$
and where the markup (and hence the labor wedge) is countercyclical

$$mc_t = \kappa(y_t - y_t^*) \rightarrow \widehat{\mu}_t = -\kappa(y_t - y_t^*)$$

r_t^n is given by the Taylor rule, equation (12)

AS Curve

The Phillips curve (14) is derived from the recursive formulation of equation (10):

$$p_t^o = (1 - \beta\theta)(mc_t + p_t) + \beta\theta E_t p_{t+1}^o \tag{15}$$

From the price index equation (9), we get:

$$p_t - p_{t-1} = \pi_t = \frac{1-\theta}{\theta}(p_t^o - p_t) \tag{16}$$

Combining (15) and (16) yields:

$$\begin{aligned}
p_t^o - p_t &= (1 - \beta\theta)mc_t + \beta\theta E_t\left[p_{t+1}^o - p_{t+1} + p_{t+1} - p_t\right] && (17)\\
\frac{\theta}{1-\theta}\pi_t &= (1 - \beta\theta)mc_t + \beta\theta E_t\left[\frac{\theta}{1-\theta}\pi_{t+1} + \pi_{t+1}\right] && (18)\\
\pi_t &= \frac{(1-\theta)(1-\beta\theta)}{\theta}mc_t + \beta E_t\pi_{t+1} && (19)
\end{aligned}$$

Inflation and Real Marginal Cost

$$\pi_t = \frac{(1-\theta)(1-\beta\theta)}{\theta} mc_t + \beta E_t \pi_{t+1}$$

- Iterating forward:

$$\pi_t = E_t \left\{ \sum_{i=0}^{\infty} \beta^i \frac{(1-\theta)(1-\beta\theta)}{\theta} (mc_{t+i}) \right\}$$

- Inflation thus depends on the expected path of real marginal cost (relative to steady state).
  - Reflects that firms price in response to current and expected future marginal cost.
  - Absent labor market frictions, real marginal cost proportionate the output gap

Loglinearization:Connecting mc_t to $y_t - y_t^*$

From the loglinearized flexible price equilibrium:

$$\begin{aligned} y_t^* &= a_t + (1-\alpha) l_t^* \\ a_t - \alpha l_t^* &= \varphi l_t^* + \gamma y_t^* \end{aligned}$$

which can be combined into

$$y_t^* = \frac{1+\varphi}{1+\varphi+(\gamma-1)(1-\alpha)} a_t \tag{20}$$

Similarly, combine (1), (7) and (8) for the sticky price eq.:

$$y_t = \frac{1+\varphi}{1+\varphi+(\gamma-1)(1-\alpha)} a_t + \frac{mc_t}{(\gamma-1)+\frac{\varphi+1}{1-\alpha}} \tag{21}$$

Then

$$y_t = y_t^* + \frac{mc_t}{(\gamma-1)+\frac{\varphi+1}{1-\alpha}} \tag{22}$$

Connecting mc_t to $y_t - y_t^*$ (con't)

- marginal cost and the output gap:

$$mc_t = \kappa(y_t - y_t^*) \tag{23}$$

with $\kappa = (\gamma - 1) + \frac{\varphi+1}{1-\alpha}$. $\equiv$ elasticity of marginal cost w.r. output.

- note: $mc_t = -\widehat{\mu}_t \rightarrow$ countercyclical markup $\rightarrow$ countercyclical labor wedge
- Combining (19) and (23) yields the New Keynesian Phillips curve (14):

$$\pi_t = \lambda(y_t - y_t^*) + \beta E_t \pi_{t+1} \tag{24}$$

with $\lambda = \frac{(1-\theta)(1-\beta\theta)}{\theta}\kappa$.

Captures short run positive relation between $y_t - y_t^*$ and π_t.
Forward looking in contrast to traditional PC: $E_t\pi_{t+1}$ enters, not π_{t-1}.

Baseline New Keynesian Model

Standard representation

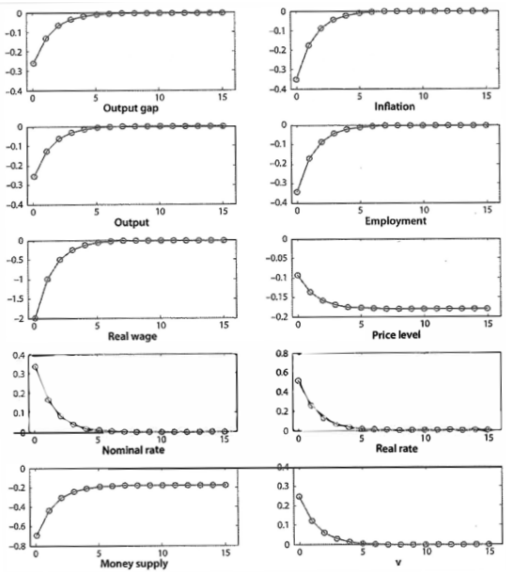
$$
\begin{aligned}
IS &: \quad y_t = -\sigma(r_t^n - E_t\pi_{t+1} - \rho) + E_t y_{t+1} \\
AS &: \quad \pi_t = \lambda(y_t - y_t^*) + \beta E_t \pi_{t+1} \\
MP &: \quad r_t^n = \rho + \phi_\pi \pi_t + \phi_y(y_t - y_t^*) + \upsilon_t
\end{aligned}
$$

with

$$
\begin{gathered}
y_t^* = \tfrac{1+\varphi}{1+\varphi+(\gamma-1)(1-\alpha)} a_t \\
a_t = \rho_a a_{t-1} + \varepsilon_{at} \\
\upsilon_t = \rho_m \upsilon_{t-1} + \varepsilon_{mt}
\end{gathered}
$$

Short run: Monetary policy non-neutral. $\upsilon_t \uparrow \rightarrow r_t^n \uparrow \rightarrow y_t \downarrow \rightarrow \pi_t \downarrow$.
Nominal price stickiness key. Note long run neutrality.

Figure 1: Dynamic Responses to a Monetary Policy Shock: Interest Rate Rule



Output Gap and the Natural Rate of Interest

Output gap: $\widetilde{y}_t = y_t - y_t^*$; Natural rate of interest $\equiv r_{t+1}^*$
y_t^* and r_{t+1}^* determined in flexible price equilibrium (independent of monetary policy)

$$y_t^* = -\sigma(r_{t+1}^* - \rho) + E_t y_{t+1}^*$$
$$y_t^* = \frac{1+\varphi}{1+\varphi+(\gamma-1)(1-\alpha)} a_t$$

$\rightarrow$

$$r_{t+1}^* = \rho + \frac{1}{\sigma}\frac{1+\varphi}{1+\varphi-(1-\gamma)(1-\alpha)}(E_t a_{t+1} - a_t))$$
$$= \rho + \frac{1}{\sigma}\frac{1+\varphi}{1+\varphi-(1-\gamma)(1-\alpha)}(\rho_a - 1)a_t$$

r_{t+1}^* depends on expected productivity growth
Note: If $\rho_a < 1$, $a_t \downarrow \rightarrow r_{t+1}^* \uparrow$

The NK Model in Terms of $\widetilde{y}_t$ and π_t

Combining sticky and flexible price equilibria $\rightarrow$

$$\widetilde{y}_t = -\sigma[(r_t^n - E_t\pi_{t+1}) - r_{t+1}^*] + E_t\widetilde{y}_{t+1}$$

$$\pi_t = \lambda(\widetilde{y}_t) + \beta E_t\pi_{t+1}$$

$$r_t^n = \rho + \phi_\pi \pi_t + \phi_y \widetilde{y}_t + \upsilon_t$$

with

$$r_{t+1}^* = \rho + \tfrac{1}{\sigma}\tfrac{1+\varphi}{1+\varphi-(1-\gamma)(1-\alpha)}(\rho_a - 1)a_t$$

$\rightarrow$ $\widetilde{y}_t$ depends inversely on "interest rate" gap $(r_t^n - E_t\pi_{t+1}) - r_{t+1}^*$
$\rightarrow$ Monetary policy affects $r_t^n - E_t\pi_{t+1}$, $\widetilde{y}_t$ and π_t but not r_{t+1}^* and y_t^*.

The Role of Expectations

We can represent the IS and AS curves as a system of simultaneous first order difference equations in $\widetilde{y}_t$ and π_t conditional on the path of the policy instrument r_t^n.

$$\widetilde{y}_t = -\sigma[(r_t^n - E_t\pi_{t+1}) - r_{t+1}^*] + E_t\widetilde{y}_{t+1}$$
$$\pi_t = \lambda(\widetilde{y}_t) + \beta E_t\pi_{t+1}$$

There are no endogenous predetermined states. Both $\widetilde{y}_t$ and π_t are endogenous at t and depend on beliefs about the future. $\rightarrow$ To solve iterate forward

$$\widetilde{y}_t = E_t{}_i^\infty - \sigma[(r_{t+i}^n - E_t\pi_{t+1+i}) - r_{t+1+i}^*]$$
$$\pi_t = E_t\left\{\sum_{i=0}^{\infty}\beta^i\lambda(\widetilde{y}_{t+i})\right\}$$

$\widetilde{y}_t$ depends inversely on expected path of interest rate gap (forward guidance matters!).
π_t depends positively on expected path of $\widetilde{y}_t$ (forward looking price setting).

Monetary Policy Design: The "Taylor" Principle

$$\widetilde{y}_t =_i -\sigma[(r^n_{t+i} - E_t\pi_{t+1+i}) - r^*_{t+1+i}]$$
$$\pi_t = E_t\left\{\sum_{i=0}^{\infty}\beta^i\lambda(\widetilde{y}_{t+i})\right\}$$

$$r^n_t = \rho + \phi_\pi\pi_t + \phi_y\widetilde{y}_t + \upsilon_t$$

Suppose the objective of policy is $\widetilde{y}_t, \pi_t = 0$.
For a unique solution for (y_t, π_t) to exist with $\lim_{i\to\infty}E_t\{\widetilde{y}_{t+i}\} = 0$ and $\lim_{i\to\infty}E_t\{\pi_{t+i}\} = 0$, it must be the case that

$$\lim_{i\to\infty}E_t\{(r^n_{t+i} - E_t\pi_{t+1+i}) - r^*_{t+1+i}\} = 0.$$

A sufficient condition to ensure convergence is that $\phi_\pi > 1$. ("Taylor" principle: see Gali).

The Taylor Principle and Macroeconomic Stability: Intuition

$$\widetilde{y}_t =_i -\sigma[(r^n_{t+i} - E_t\pi_{t+1+i}) - r^*_{t+1+i}]$$
$$\pi_t = E_t\left\{\sum_{i=0}^{\infty}\beta^i\lambda(\widetilde{y}_{t+i})\right\}; \qquad r^n_t = \rho + \phi_\pi\pi_t + \phi_y\widetilde{y}_t + \upsilon_t$$

Intuitively, suppose $r^*_{t+1}\uparrow$ (due e.g. to a drop in a_t) $\rightarrow \widetilde{y}_t\uparrow$ (given r^n_t) $\rightarrow \pi_t\uparrow$.

If $\phi_\pi > 1 \rightarrow r^n_{t+i}\uparrow$ enough to raise real rates $r^n_{t+i} - E_t\pi_{t+1+i} \rightarrow$ $r^n_{t+i} - E_t\pi_{t+1+i}$ converges to $r^*_{t+1+i} \rightarrow \widetilde{y}_{t+i}$ and $\pi_{t+i} \rightarrow 0$

$\phi_\pi > 1$ also eliminates self-fulfilling movements in inflation.

Suppose $E_t\pi_{t+1}\uparrow \rightarrow (r^n_t - E_t\pi_{t+1})\downarrow$ (given r^n_t)$\rightarrow \widetilde{y}_t\uparrow\rightarrow \pi_t\uparrow$

With $\phi_\pi > 1 \rightarrow r^n_t\uparrow$ enough to raise real rates, choking off self-fulfilling inflation

Evidence: $\phi_\pi < 1$ from mid 60s to late 70s, a period of volatile inflation and output

Conversely, $\phi_\pi > 1$ from early 1980s to 2007, the Great Moderation.

The Taylor Principle and Macroeconomic Stability: Formalities

$$\widetilde{y}_t = -\sigma[(r_t^n - E_t\pi_{t+1}) - r_{t+1}^*] + E_t\widetilde{y}_{t+1}$$
$$\pi_t = \lambda(\widetilde{y}_t) + \beta E_t\pi_{t+1}$$
$$r_t^n = \rho + \phi_\pi\pi_t + \phi_y\widetilde{y}_t + \upsilon_t$$

Use the policy rule to eliminate r_t^n in the IS equation$\rightarrow$

$$\begin{bmatrix} \widetilde{y}_t \\ \pi_t \end{bmatrix} = A \begin{bmatrix} E_t\widetilde{y}_{t+1} \\ E_t\pi_{t+1} \end{bmatrix} + B \cdot u_t$$

where A is 2x2 and B is 2x1.

Unique solution exists if the two roots of A lie within the unit circle.

$\rightarrow$ unique solution can be obtained through forward iteration.

Sufficient condition for the roots of A in the unit circle: $\phi_\pi > 1$. (Gali p.65)

Optimal Policy Rule: Given objective $\widetilde{y}_t, \pi_t = 0$

$$\widetilde{y}_t =_i -\sigma[(r^n_{t+i} - E_t\pi_{t+1+i}) - r^*_{t+1+i}]$$
$$\pi_t = E_t \left\{ \sum_{i=0}^{\infty} \beta^i \lambda(\widetilde{y}_{t+i}) \right\}$$

Preferable policy rule (ignoring issues of commitment for now):

$$r^n_{t+i} = r^*_{t+1+i} \; \forall i \geq 0 \rightarrow \widetilde{y}_t, \pi_t = 0$$

To ensure $\pi_t \rightarrow 0$, need to specify that policy will adjust if π_t deviates from 0 :
A rule that accomplishes this is

$$r^n_t = r^*_{t+1} + \phi_\pi \pi_t \text{ with } \phi_\pi > 1$$

As in the previous case, $\phi_\pi > 1$ ensures a determinate solution for $\widetilde{y}_t$ and π_t (thus ruling out self-fulfilling solutions).
The difference in this case is that $\widetilde{y}_t$ and π_t go right to 0.

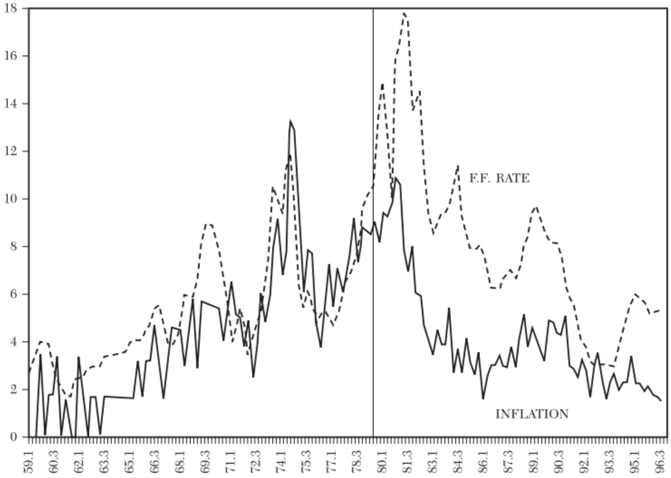


Figure 4. The Federal Funds Rate and the Inflation Rate

TABLE 1
ESTIMATES OF POLICY REACTION FUNCTION

	γ_π	γ_x	ρ
Pre-Volcker	0.83	0.27	0.68
	(0.07)	(0.08)	(0.05)
Volcker–Greenspan	2.15	0.93	0.79
	(0.40)	(0.42)	(0.04)

Demand Shocks

Standard approach: preference shifter to induce fluctuations in consumption demand
Note: pandemic interpretable as temporary shock to demand b, along with shock to labor supply ζ (which we will ignore for now).
Modify utility function as follows:

$$E_t\{\sum_{i=0}^{\infty}\beta^i e^{b_{t+i}}[\frac{1}{1-\gamma}C_{t+i}^{1-\gamma}-\frac{e^{\zeta_{t+i}}}{1+\varphi}L_{t+i}^{1+\varphi}]\}$$

where the preference shock b_t obeys

$$b_t=\rho_b b_{t-1}+\varepsilon_{bt}$$

$\rightarrow$ Consumption euler equation:

$$e^{b_t}C_t^{-\gamma}=E_t\{\beta e^{b_{t+1}}C_{t+1}^{-\gamma}R_t^n\frac{P_t}{P_{t+1}}\}$$

Demand Shocks (con't)

In loglinear form (given $\sigma = 1/\gamma$)

$$\begin{aligned} c_t &= -\sigma[(r_t^n - E_t\pi_{t+1}) - \rho] + E_t\{c_{t+1}\} + \sigma(b_t - E_t\{b_{t+1}\}) \\ &= -\sigma[(r_t^n - E_t\pi_{t+1}) - \rho] + E_t\{c_{t+1}\} + \sigma(1-\rho_b)b_t \end{aligned}$$

since $y_t = c_t$:

$$y_t = -\sigma[(r_t^n - E_t\pi_{t+1}) - \rho] + E_t\{y_{t+1}\} + \sigma(1-\rho_b)b_t$$

natural rate of interest:

$$y_t^* = -\sigma[r_{t+1}^* - \rho] + E_t\{y_{t+1}^*\} + \sigma(1-\rho_b)b_t$$

$\rightarrow r_{t+1}^*$ depends on b_t and a_t

IS/AS Model with Demand Shocks

Given $\widetilde{y}_t = y_t - y_t^*$

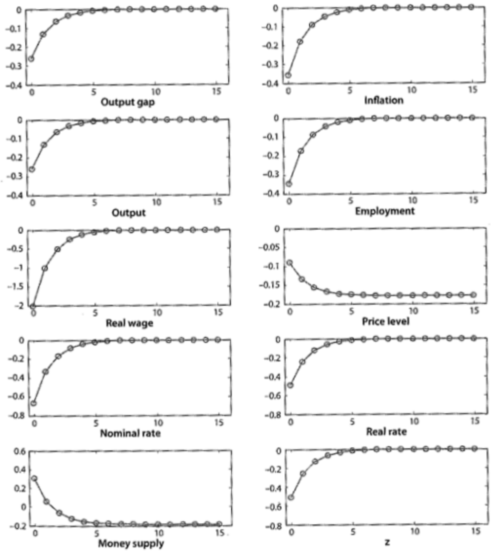
$$\widetilde{y}_t = -\sigma[(r_t^n - E_t\pi_{t+1}) - r_{t+1}^*] + E_t\widetilde{y}_{t+1}$$
$$\pi_t = \lambda(\widetilde{y}_t) + \beta E_t\pi_{t+1}$$

with

$$y_t^* = \frac{1+\varphi}{1+\varphi+(\gamma-1)(1-\alpha)} a_t$$
$$r_{t+1}^* = \rho + \frac{1}{\sigma}\frac{1+\varphi}{1+\varphi-(1-\gamma)(1-\alpha)}(\rho_a - 1)a_t + (1-\rho_b)b_t$$

r_{t+1}^* summarizes the effect of b_t and a_t relevant to monetary policy.
Optimal to continue to set $r_t^n = r_{t+1}^*$.
Complication: r_{t+1}^* not directly observable (though π_t provides information).

Figure 2: Dynamic Responses to a Discount Rate Shock: Interest Rate Rule



Baseline New Keynesian Model: Properties

- $\widetilde{y}_t$ depends inversely on current and expected future movements of $(r^n_{t+i} - E_t\pi_{t+1+i})$ relative to r^*_{t+1+i} (which summarizes effects of shocks)
- π_t depends positively on current and expected future movements of $\widetilde{y}_t$.
- No short run trade-off between π_t and $\widetilde{y}_t$ for a **credible** central bank (i.e. a central bank that can commit to keeping $\widetilde{y}_{t+i} = 0\ \forall i > 0$.
    - Requires committing to adjust path of r^n_{t+i} so $(r^n_{t+i} - E_t\pi_{t+1+i}) - r^*_{t+1+i} = 0\ \forall i$.
    - Result depends on absence of labor market frictions (otherwise mc_t not simply proportionate to $\widetilde{y}_t$).
    - If steady state output is inefficiently low (e.g. due to imperfect competition), the central might be tempted to inflate.
    - If zero lower bound on the nominal rate binds, the economy is susceptible to deflation and output losses.

Liquidity Trap and the Zero Lower Bound (ZLB)

- Liquidity trap: a situation where the central bank cannot stimulate the economy by reducing the short term interest rate.

- Emerges when ZLB constraint on net nominal interest rate binds
  - ZLB: $R_t^n - 1 \geq 0 \Leftrightarrow R_t^n \geq 1 \Leftrightarrow \log R_t^n = r_t^n \geq 0$
  - From earlier: desirable to set $r_t^n = r_{t+1}^*$ (natural interest rate) $\rightarrow$

- ZLB binds if natural real rate $R_{t+1}^* < 1 \Leftrightarrow r_{t+1}^* < 0$ where $r_{t+1}^* = \log R_{t+1}^*$

- Deflationary spiral can emerge, with $\widetilde{y}_t < 0$ and $\pi_t < 0$.

Liquidity Trap and the Zero Lower Bound (con't)

- Suppose:
  - for k periods $r^*_{t+1+i} < 0$
  - central bank pushes r^n_{t+i} to ZLB over this period $\rightarrow r^n_{t+i} = 0$

$$\widetilde{y}_t = E_t\{{}_{i=0}^{k-1} - \sigma[(-E_t\pi_{t+1+i}) - r^*_{t+1+i}] + {}_{i=k}^{\infty} - \sigma[(r^n_{t+i} - E_t\pi_{t+1+i}) - r^*_{t+1+i}]\}$$

- If for $i \geq k+1$, $(r^n_{t+i} - E_t\pi_{t+1+i}) = r^*_{t+1+i}$:

$$\widetilde{y}_t = E_t\{{}_{i=0}^{k-1} - \sigma[(-E_t\pi_{t+1+i}) - r^*_{t+1+i}]\}$$

- $r^*_{t+1+i} < 0 \rightarrow$ a liquidity trap emerges with $\widetilde{y}_{t+i}, \pi_{t+i} < 0$ until $i \geq k+1$.

Escaping A Liquidity Trap

- Way out - commit to inflation after r^*_{t+1+i} becomes positive.

$$\widetilde{y}_t =_{i=0}^{k-1} -\sigma[(-E_t\pi_{t+1+i}) - r^*_{t+1+i}] +_{i=k}^{\infty} -\sigma[(r^n_{t+i} - E_t\pi_{t+1+i}) - r^*_{t+1+i}]$$

- That is commit to $[(r^n_{t+1+i} - E_t\pi_{t+1+i}) - r^*_{t+1+i}] < 0$ for $i \geq k+1$.
- Note that this implies $\pi_{t+i} > 0$ if this commitment is kept $\Rightarrow$ credibility problem: Incentive to renege when out of liquidity trap.
- Fiscal policy may be an alternative (to raise r^*_{t+1+i}).
- In an economy with financial market frictions, credit policy may also be an alternative.

The Recent Inflation Surge: A Sketch

- Following the pandemic, sharp increase in demand ($b_t \uparrow$) and contraction in supply ($a_t \downarrow$)
  - Sources of demand boom: waning of virus, fiscal and monetary policy
  - Supply: supply chain disruptions, oil and food prices, decline in labor supply
- $b_t \uparrow$ and $a_t \downarrow \rightarrow r^*_{t+1} \uparrow$

$$r^*_{t+1} = \rho + \frac{1}{\sigma}\frac{1+\varphi}{1+\varphi-(1-\gamma)(1-\alpha)}(\rho_a - 1)a_t + (1-\rho_b)b_t$$

- If central bank is slow to increase rates (as occurred in practice)$\rightarrow$

$$(r^n_{t+i} - E_t\pi_{t+1+i}) - r^*_{t+1+i} < 0$$

$\rightarrow \widetilde{y}_t \uparrow$ and $\pi_t \uparrow$.

Oil Inflation and Fed Funds Rate