Macroeconomics
Lecture 12 – Topics in Macroeconomic Policy

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Outline

1. Monetary policy: discretion vs. commitment
   - Optimal discretionary policy
   - Optimal policy with commitment

2. Fiscal policy
   - Government budget sustainability
   - Ricardian equivalence
   - RBC with government and lump-sum taxes

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Goals of monetary policy

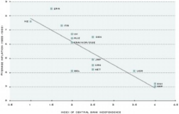
So far, policy monetary modelling in New Keynesian model followed **positive**, or descriptive, approach → **Taylor Rule**

Sufficient reaction to inflation ⇒ **active** Taylor Rule ⇒ equilibrium **determinacy** (Blanchard Kahn)

How about other goals?

- Maximize household utility (case of **benevolent** central bank)
- Other incentives (e.g. non-benevolent government & non-independent central bank) ⇒ suboptimal focus on GDP, neglect of inflation

Central bank independence and inflation: data



Source. Federal Reserve Bank of St. Louis Annual Report 2009, Figure 1.

Central Bank loss function

Consider the following **loss function** of the central bank (CB):

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{1}{2} \left(\pi_t^2 + \alpha_x x_t^2 \right)$$

where $x_t = y_t - y_t^e$ and y_t^e is the log of **efficient GDP** (what a social planner would choose)

$y_t \neq y_t^e (\neq y_t^f)$, because of sticky prices and market power of firms

In case of **benevolent CB**, $\alpha_x = \frac{\kappa}{\varepsilon}$, with κ the slope of the New Keynesian Phillips curve and ε the elasticity of goods substitution.
CB non-independent $\Rightarrow \alpha_x$ too high

Why inflation affects welfare? Recall that GDP depends on **price dispersion**: $y_t = a_t + (1-\alpha)n_t - (1-\alpha)\ln\left[\int_0^1 \left(\frac{P_t(i)}{P_t} di\right)^{\frac{\varepsilon}{1-\alpha}}\right]$ and **price dispersion is higher with higher inflation**

Phillips Curve with supply shock

$$\pi_t = \beta E_t \pi_{t+1} + \kappa \tilde{y}_t \qquad \text{(New Keynesian Phillips curve)}$$

...can be rewritten to have x_t instead of $\tilde{y}_t$:

$$\tilde{y}_t = y_t - y_t^f = y_t - y_t^e + (y_t^e - y_t^f) = x_t + y_t^e - y_t^f$$

so:

$$\begin{aligned}\pi_t &= \beta E_t \pi_{t+1} + \kappa(x_t + y_t^e - y_t^f) \\ &= \beta E_t \pi_{t+1} + \kappa x_t + \underbrace{\kappa(y_t^e - y_t^f)}_{s_t}\end{aligned}$$

$\pi_t = \beta E_t \pi_{t+1} + \kappa x_t + s_t$

s_t assumed random: a **supply-side shock** a.k.a. cost-push shock

We will study a response of the CB to a one-off increase in s_t

Discretion vs. commitment

A policy that is decided upon each period is called **discretionary policy**

- advantage – immediate reaction to shocks
- disadvantage – the Central Bank does not follow a rule $\Rightarrow$ does not influence $E_t\pi_{t+1}$, which determines π_t

A policy that is pre-announced and always enacted as announced is a policy with **commitment**

We will look at discretionary and commitment policies in turn

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Discretionary policy: static problem

The Central Bank only looks at period t trade-off between output gap and inflation:

$$\mathcal{L} = \frac{1}{2}(\pi_t^2 + \alpha_x x_t^2) + \lambda(\pi_t - \beta E_t \pi_{t+1} - k x_t - s_t)$$

$$\min_{\pi_t, x_t} \frac{1}{2}(\pi_t^2 + \alpha_x x_t^2)$$

$$\text{s.t.} \quad \pi_t = \underbrace{\beta E_t \pi_{t+1}}_{\text{ignored}} + \kappa x_t + s_t$$

$$\frac{\partial \mathcal{L}}{\partial \pi_t} = \pi_t + \lambda = 0$$

$$\frac{\partial \mathcal{L}}{\partial x_t} = \alpha_x x_t - \lambda k = 0$$

Households and firms do not know the loss function of the CB $\Rightarrow$ cannot solve CB problem for future periods $\Rightarrow$ expectations not influenced by discretionary policy, can be ignored in minimization

$$\alpha_x x_t = -k\pi_t$$

Current shock value s_t is **known** by CB, future ones expected null

$$x_t = -\frac{k}{\alpha_x}\pi_t$$

Solution $x_t = -\frac{\kappa}{\alpha_x}\pi_t$

Shock response: inflation and output

$s_0 > 0\,;\; s_t = 0\,,\; t \geq 1$

$\pi_t = \beta \mathbb{E}_t \pi_{t+1} + \kappa x_t + s_t\,;\quad x_t = -\frac{\kappa}{\alpha_x}\pi_t$

$1 + \frac{\kappa^2}{\alpha_x} = \frac{\alpha_x + \kappa^2}{\alpha_x}$

$\pi_t = \beta \mathbb{E}_t \pi_{t+1} + \kappa \cdot \left(-\frac{\kappa}{\alpha_x}\right)\pi_t + s_t$

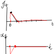
$\left(1 + \frac{\kappa^2}{\alpha_x}\right)\pi_t = \beta \mathbb{E}_t \pi_{t+1} + s_t \;\Big|\times \frac{\alpha_x}{\alpha_x + \kappa^2}$

$\pi_t = \frac{\beta \alpha_x}{\alpha_x + \kappa^2}\mathbb{E}_t \pi_{t+1} + \frac{\alpha_x}{\alpha_x + \kappa^2} s_t$

$\pi_t = \mathbb{E}_t \sum_{k=0}^{\infty} \left(\frac{\beta \alpha_x}{\alpha_x + \kappa^2}\right)^k \frac{\alpha_x}{\alpha_x + \kappa^2} \cdot s_{t+k}$

$\pi_0 = \frac{\alpha_x}{\alpha_x + \kappa^2} s_0\,;\; \pi_t = 0\,,\; t > 0$

$x_0 = -\frac{\kappa}{\alpha_x + \kappa^2} s_0\,;\; x_t = 0\,,\; t > 0$



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Policy with commitment: dynamic problem

$$\min_{\{\pi_t, x_t\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t \frac{1}{2}\left(\pi_t^2 + \alpha_x x_t^2\right)$$

$$\pi_t = \underbrace{\beta E_t \pi_{t+1}}_{\text{chosen by CB}} + \kappa x_t + s_t$$

omitted by law of iter. exp

$E_0 E_t \pi_{t+1}$

$$\mathcal{L} = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{1}{2}\left(\pi_t^2 + \alpha_x x_t^2\right) + \lambda_t \left(\pi_t - \beta \pi_{t+1} - \kappa x_t - s_t\right)\right)$$

$$\mathcal{L} = \ldots$$

$$+ \mathbb{E}_0 \beta^t \left(\frac{1}{2}\left(\pi_t^2 + \alpha_x x_t^2\right) + \lambda_t \left(\pi_t - \beta \pi_{t+1} - \kappa x_t - s_t\right)\right)$$

$$+ \mathbb{E}_0 \beta^{t+1} \left(\frac{1}{2}\left(\pi_{t+1}^2 + \alpha_x x_{t+1}^2\right) + \lambda_{t+1} \left(\pi_{t+1} - \beta \pi_{t+2} - \kappa x_{t+1} - s_{t+1}\right)\right)$$

$$+ \ldots$$

$$\frac{\partial \mathcal{L}}{\partial \pi_{t+1}} = \mathbb{E}_0 \beta^t \lambda_t (-\beta) + \mathbb{E}_0 \beta^{t+1} \left(\pi_{t+1} + \lambda_{t+1}\right) = 0;$$

$$\mathbb{E}_0 \lambda_t = \mathbb{E}_0 \left[\pi_{t+1} + \lambda_{t+1}\right]$$

$\mathcal{L} = \dots$

$\mathbb{E}_0 \beta^t \left(\frac{1}{2}(\pi_t^2 + \alpha_x x_t^2) + \lambda_t(\pi_t - \beta \pi_{t+1} - \kappa x_t - s_t) \right)$

$+ \mathbb{E}_0 \beta^{t+1} \left(\frac{1}{2}(\pi_{t+1}^2 + \alpha_x x_{t+1}^2) + \lambda_{t+1}(\pi_{t+1} - \beta \pi_{t+2} - \kappa x_{t+1} - s_{t+1}) \right)$

$+ \dots$

$\frac{\partial \mathcal{L}}{\partial \pi_{t+1}} = \mathbb{E}_0 \beta^t \lambda_t (-\beta) + \mathbb{E}_0 \beta^{t+1} (\pi_{t+1} + \lambda_{t+1}) = 0 \ ;$ $\quad \lambda_t = \mathbb{E}_0 [\pi_{t+1} + \lambda_{t+1}]$

in $t = 0$ $\lambda_0 = \pi_1 + \lambda_1$

$\underbrace{\lambda_{-1}}_{0} = \pi_0 + \lambda_0 \ , \Rightarrow \pi_0 = -\lambda_0$

$\frac{\partial \mathcal{L}}{\partial x_t} = \mathbb{E}_0 \beta^t (\alpha_x x_t - \lambda_t \kappa) = 0 \iff \mathbb{E}_0 x_t = \frac{\kappa}{\alpha_x} \mathbb{E}_0 \lambda_t$

$\Rightarrow \boxed{x_0 = \frac{\kappa}{\alpha_x} \lambda_0 = -\frac{\kappa}{\alpha_x} \pi_0}$

$$\left.\begin{array}{l} \mathbb{E}_0 \lambda_t = \mathbb{E}_0[\pi_{t+1} + \lambda_{t+1}] \\ \mathbb{E}_0 x_t = \frac{\kappa}{\alpha_x} \mathbb{E}_0 \lambda_t \end{array}\right\} \Rightarrow$$

Period t perspective:

$$\lambda_t = \mathbb{E}_t[\pi_{t+1} + \lambda_{t+1}]$$

$$x_t = \frac{\kappa}{\alpha_x} \lambda_t \Leftrightarrow \lambda_t = \frac{\alpha_x}{\kappa} x_t$$

$$\lambda_t = \underbrace{\mathbb{E}_t \pi_{t+1}}_{\text{chosen}} + \underbrace{\mathbb{E}_t \frac{\alpha_x}{\kappa} x_{t+1}}_{\text{chosen}} \Rightarrow \mathbb{E}_t \text{ dropped}$$

$$x_0 = -\frac{\kappa}{\alpha_x} \pi_0$$

$$\frac{\alpha_x}{\kappa} x_t = \pi_{t+1} + \frac{\alpha_x}{\kappa} x_{t+1} \quad \Big| \times \frac{\kappa}{\alpha_x}$$

$$x_t = \frac{\kappa}{\alpha_x} \pi_{t+1} + x_{t+1}$$

$$\pi_0 + \pi_1 = p_0 - p_{-1} + p_1 - p_0 = p_1 - p_{-1}$$

$$x_{t-1} = \frac{\kappa}{\alpha_x} \pi_t + x_t \Rightarrow x_t = x_{t-1} - \frac{\kappa}{\alpha_x} \pi_t$$

$$x_1 = -\frac{\kappa}{\alpha_x} \pi_0 - \frac{\kappa}{\alpha_x} \pi_1 = -\frac{\kappa}{\alpha_x}(\pi_0 + \pi_1)$$

$$x_2 = x_1 - \frac{\kappa}{\alpha_x} \pi_2 = -\frac{\kappa}{\alpha_x}(\pi_0 + \pi_1 + \pi_2)$$

$$x_t = -\frac{\kappa}{\alpha} \sum_{k=0}^{t} \pi_k = -\frac{\kappa}{\alpha}(p_t - p_{-1}) \Leftarrow$$

$$x_t = -\frac{\kappa}{\alpha_x}\sum_{k=0}^{t}\pi_k$$
$$= -\frac{\kappa}{\alpha_x}(p_t - p_{-1})$$

$$\pi_t = \beta \mathbb{E}_t \pi_{t+1} + \kappa x_t + s_t$$

$$p_t - p_{t-1} = \beta \mathbb{E}_t (p_{t+1} - p_t) + \kappa\left(-\frac{\kappa}{\alpha_x}\right)(p_t - p_{-1}) + s_t$$

Diff equation of order 2, solution:

$1 + \pi_t$

$$p_t - p_{-1} = \delta (p_{t-1} - p_{-1} + s_t)$$

$$\delta = \frac{1 - \sqrt{1 - 4\beta a^2}}{2a\beta}$$

$$p_0 - p_{-1} = \delta s_0$$

$$a = \frac{\alpha_x}{\alpha_x(1+\beta) + \kappa^2}$$

$$\boxed{x_t = \frac{\kappa\delta}{\alpha_x}\left(\frac{\alpha_x}{\kappa} x_{t-1} + s_t\right)}$$

Policy with commitment: solution

The optimality condition is in terms of price level, or cumulative inflation:

$$x_t = -\frac{\kappa}{\alpha_x}(p_t - p_{-1}) = -\frac{\kappa}{\alpha_x}\sum_{k=0}^{t}\pi_k$$

Using Phillips curve, price level dynamics is:

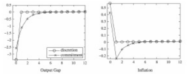
$$p_t - p_{-1} = \delta(p_{t-1} - p_{-1} + s_t)$$

with $\delta = \frac{1-\sqrt{1-4\beta a^2}}{2a\beta}$ and $a = \frac{\alpha_x}{\alpha_x(1+\beta)+\kappa^2}$

Output gap dynamics is then:

$$x_t = \delta x_{t-1} - \frac{\kappa\delta}{\alpha_x}s_t \; ; \; x_0 = -\frac{\kappa\delta}{\alpha_x}s_0$$

Discretion vs. commitment: impulse responses



Source. Galí textbook, Figure 5.1.

Commitment improves both output gap and inflation in $t = 0$

How? → by creating expectations about lower future inflation, via persistent negative output gap

In sum, output-inflation trade-off is better over the long horizon ⇒ CB losses smaller under commitment

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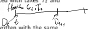
Government budget constraint

The government has real spending G_t financed with taxes T_t and **government debt** accumulation $D_{t+1} - D_t$



The government budget constraint can be written with the same logic as for household:

$$G_t + r_{t-1}D_t = T_t + D_{t+1} - D_t$$

$$\Leftrightarrow \quad D_{t+1} - D_t = \underbrace{\underbrace{r_{t-1}D_t}_{\textbf{debt service}} + \underbrace{G_t - T_t}_{\textbf{primary deficit}}}_{\textbf{total deficit}}$$

$$\Leftrightarrow \quad D_{t+1} = D_t(1 + r_{t-1}) + G_t - T_t$$

Last equation – **recursive** (as many others in course) $\Rightarrow$ can express D_0 it as an infinite sum

Government budget sustainability

$$D_0 = \sum_{t=0}^{\infty} \frac{T_t - G_t}{R_{0,t}} + \underbrace{\lim_{t\to\infty} \frac{D_t}{R_{0,t}}}_{=0}$$

with cumulative returns defined as:
$R_{0,0} = 1$, $R_{0,1} = (1 + r_0)$, $R_{0,2} = (1 + r_0)(1 + r_1)$ and
$R_{0,t} = (1 + r_0)(1 + r_1)...(1 + r_{t-1})$

- Future **primary surpluses** must be used to repay initial government debt
- The earlier primary surplus in the future, the more impact on debt dynamics
- **Interest rates matter** $\Rightarrow$ one can have a New Keynesian model with CB setting nominal rates $\rightarrow$ government has incentive to put pressure on CB for lower rates!

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Government budget and private budget

Budget constraint of an household in RBC with **lump-sum** taxes:

$$C_t + I_t + B_{t+1} = w_t N_t + (1 + r_{t-1})B_t + R_t K_t + \Pi_t - T_t$$

with $I_t = K_{t+1} - (1 - \delta)K_t$ and $D_{t+1} = (1 + r_{t-1})D_t + G_t - T_t$

Solve government budget for T_t, replace in household budget:

$$\begin{aligned} C_t + I_t + B_{t+1} = & w_t N_t + (1 + r_{t-1})B_t + R_t K_t + \Pi_t \\ & - G_t - (1 + r_{t-1})D_t + D_{t+1} \end{aligned}$$

Bonds used by household are **government bonds**, so $B_t = D_t$ and:

$$\begin{aligned} C_t + I_t + D_{t+1} = & w_t N_t + (1 + r_{t-1})D_t + R_t K_t + \Pi_t \\ & - G_t - (1 + r_{t-1})D_t + D_{t+1} \end{aligned}$$

$$\Leftrightarrow \quad C_t + I_t = w_t N_t + R_t K_t + \Pi_t - G_t$$

Ricardian equivalence

$$C_t + I_t = w_t N_t + R_t K_t + \Pi_t - G_t$$

the obtained expression is equivalent to household budget with $B_t = D_t = 0$ and $T_t = G_t$

$\Rightarrow$ household choices and model dynamics are **only influenced by the values of government spending, but not by the way it is financed**

$\Rightarrow$ government debt accumulation is **neutral** for economy dynamics

Idea dating back to David Ricardo (early 19th century) $\rightarrow$ **Ricardian equivalence**

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Use the joint budget constraint obtained before:

$$\max_{C_t, N_t, K_{t+1}, B_{t+1}} E_0 \sum_{t=0}^{\infty} \beta^t u(C_t, N_t, G_t)$$

$$\text{s.t.} \quad C_t + I_t + B_{t+1} = w_t N_t + R_t K_t + (1 + r_{t-1}) B_t + \Pi_t - T_t$$

$$K_{t+1} = (1-\delta) K_t + I_t$$

$$D_{t+1} = (1 + r_{t-1}) D_t + G_t - T_t$$

as before, B_{t+1} is only needed to obtain the Euler equation; it is neutral by Ricardian equivalence

RBC with government – closing the model

Preferences:

- Assume $u(C_t, N_t, G_t)$ additively separable in (C_t, N_t) and G_t
  - e.g. $\ln C_t - \theta \frac{N_t^{1+\eta}}{1+\eta} + \frac{G_t^{1-\gamma}}{1-\gamma}$
- Then u'_C, u'_N do not depend on $G_t \Rightarrow$ **no direct effect on household choices**

$\ln G_{ss} = (1-\rho_g)\ln(\omega Y_{ss}) + \rho_g \ln G_{ss}$

$\cancel{(1-\rho_g)} \ln G_{ss} = \cancel{(1-\rho_g)} \ln(\omega Y_{ss})$

$G_{ss} = \omega Y_{ss}$

Aggregate resource constraint:

$$Y_t = A_t F(K_t, N_t) = C_t + I_t + G_t$$

Government spending can follow an AR(1), like TFP:

- $\ln G_t = (1-\rho_g)\ln(\omega Y_{ss}) + \rho_g \ln G_{t-1} + \varepsilon_t^G \Rightarrow G_{ss} = \omega Y_{ss}$
- $\ln A_t = \rho_A \ln A_{t-1} + \varepsilon_t^A$

Effect of government spending on consumer

Ricardian equivalence: any fiscal policy $\{G_t, T_t, D_t\}_{t=0}^{\infty}$ with lump-sum taxes will have the same effect as the policy $\{G_t\}_{t=0}^{\infty}, T_t = G_t, D_t = 0$:

$$C_t + I_t = w_t N_t + R_t K_t + \Pi_t - G_t$$

The effect of an increase of G_t is then same as a negative income shock from consumer perspective:

- Use intuition on consumption smoothing to understand response of C_t, I_t & intuition on leisure as normal good for labor response
- Response of Y_t more ambiguous since $Y_t = C_t + I_t + G_t$, but tends to be positive

⇒ If government spending shock is the only source of cycles, C_t **countercyclical** ⇒ worse empirical performance than TFP shock

Impulse responses – positive shock of G

Cobb-Douglas production, $u(C_t, L_t, G_t) = lnC_t - \theta\frac{L_t^{1+\eta}}{1+\eta} + \frac{G_t^{1-\gamma}}{1-\gamma}$ and

α	β	η	δ	θ	ρ_a	ρ_g	ω
1/3	0.99	1	0.025	4	0.97	0.95	0.2