Optimal Monetary and Fiscal Policy in a Liquidity Trap

Eggertsson and Woodford (2003, 2004)   ECON 7640 Presentation

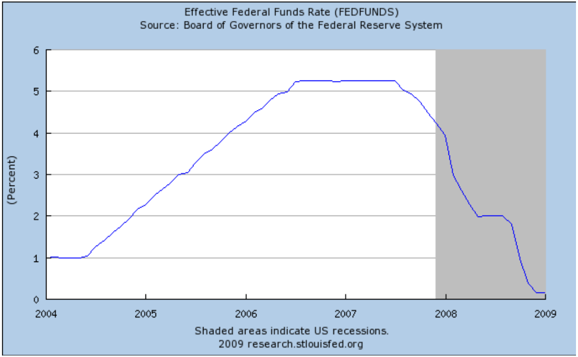
February 18th, 2009

Motivation

- Benigno and Woodford (2003): forward-looking targeting rule is the optimal monetary and fiscal policy if there is no zero bound
- Japan and U.S. case: zero bound is relevant and binding
- Must consider optimal policy in the case of a binding zero bound on the nominal interest rate
- Eggertsson and Woodford (2003): Optimal monetary policy with binding zero bound and no fiscal policy
- Eggertsson and Woodford (2004): Optimal monetary and fiscal policy with binding zero bound

Importance of the Zero Bound

- The Natural Rate of Interest might become temporarily negative
- Zero bound on nominal interest rates limits monetary policy in preventing deflation and under-utilization of productive capacity



- Must consider how optimal monetary and fiscal policy changes when the zero bound becomes relevant

Outline

- Model Setup
- If NO Fiscal Policy is Available:
    1. Optimal Monetary Policy with the Zero Bound
- If Fiscal Policy is Available:
    1. Optimal Monetary Policy with the Zero Bound
    2. Optimal Fiscal Policy with the Zero Bound

The Model

- Policy goal: maximize representative household's expected utility:
- Household's utility:
- $$U_{t_0} \equiv E_{t_0} \sum_{t=t_0}^{\infty} \beta^{t-t_0} \left[\tilde{u}(C_t;\xi_t) - \int_0^1 \tilde{v}(H_t(j);\xi_t)dj \right]$$
- where
- $$C_t \equiv \left[\int_0^1 c_t(i)^{\frac{\theta}{\theta-1}} di \right]^{\frac{\theta-1}{\theta}}$$

The Model

$$\tilde{u}(C_t;\xi_t) \equiv \frac{C_t^{1-\tilde{\sigma}^{-1}}\bar{C}_t^{\tilde{\sigma}^{-1}}}{1-\tilde{\sigma}^{-1}},$$

- $$\tilde{v}(H_t;\xi_t) \equiv \frac{\lambda}{1+\nu} H_t^{1+\nu} \bar{H}_t^{-\nu}$$

- Production Technology:

$$y_t(i) = A_t f(h_t(i)) = A_t h_t(i)^{1/\phi}$$

- Identity:

$$Y_t = C_t + G_t$$

Staggered Prices

- α: fraction of prices which remain unchanged in a period
- Price-changing suppliers change their price to maximize:

$$E_t \left\{ \sum_{T=t}^{\infty} \alpha^{T-t} Q_{t,T} \Pi(p_t(i), p_T^j, P_T; Y_T, \tau_T, \xi_T) \right\}$$

- Each supplier faces Dixit-Stiglitz demand curve:

$$y_t(i) = Y_t(p_t(i)/P_t)^{-\theta}$$

Profit Function

$$\Pi(p, p^j, P; Y, \tau, \xi) \equiv (1-\tau) p Y (p/P)^{-\theta}$$

$$-\mu^w \frac{\tilde{v}_h(f^{-1}(Y(p^j/P)^{-\theta}/A); \xi)}{\tilde{u}_c(Y - G; \xi)} P \cdot f^{-1}(Y(p/P)^{-\theta}/A)$$

Optimal Choice of Price

- Since each supplier chooses the same price $p_t(i) = p_j(j) = p^*$, the First Order Condition:

$$E_t \left\{ \sum_{T=t}^{\infty} \alpha^{T-t} u_c(Y_T;\xi_T) \left(\frac{p_t^*}{P_T} \right)^{-\theta} Y_T \left[\frac{p_t^*}{P_T}(1-\tau_T) - \frac{\theta}{\theta-1} \mu_T^w \frac{v_y(Y_T(p_t^*/P_T)^{-\theta};\xi_T)}{u_c(Y_T;\xi_T)} \right] \right\} = 0$$

Solution for Optimal Price

- Solving for the Optimal Relative Price:

$$\frac{p_t^*}{P_t} = \left(\frac{K_t}{F_t}\right)^{\frac{1}{1+\omega\theta}}$$

- ω: elasticity of real marginal cost with respect to industry output
- $(F; K) = f\,(Y_t; \tau_t; \xi_t)$
- τ_t: distortionary tax proportional to sales revenues

Solution for Optimal Price

- where:

$$F_t \equiv E_t \sum_{T=t}^{\infty} (\alpha\beta)^{T-t}(1-\tau_T) f(Y_T;\xi_T)\left(\frac{P_T}{P_t}\right)^{\theta-1}$$

$$K_t \equiv E_t \sum_{T=t}^{\infty} (\alpha\beta)^{T-t} k(Y_T;\xi_T)\left(\frac{P_T}{P_t}\right)^{\theta(1+\omega)}$$

$$f(Y;\xi) \equiv u_c(Y;\xi)Y,$$

$$k(Y;\xi) \equiv \frac{\theta}{\theta-1}\mu^w v_y(Y;\xi)Y.$$

- Substituting the Optimal Relative Price into the Law of motion of prices:

$$P_t = \left[(1-\alpha) p_t^{*1-\theta} + \alpha P_{t-1}^{1-\theta} \right]^{\frac{1}{1-\theta}}$$

- Yields the Short-run aggregate supply relation (1):

$$\frac{1-\alpha \Pi_t^{\theta-1}}{1-\alpha} = \left(\frac{F_t}{K_t} \right)^{\frac{\theta-1}{1+\omega\theta}}$$

- i_t: riskless short-term nominal interest rate controlled by central bank
- Arbitrage relation:

$$1 + i_t = \left[E_t Q_{t,t+1}\right]^{-1}$$

- Equilibrium discount factor:

$$Q_{t,T} = \beta^{T-t} \frac{\tilde{u}_c(C_T; \xi_T)}{\tilde{u}_c(C_t; \xi_t)} \frac{P_t}{P_T}$$

- Path of Nominal Interest Rates (2) :

$$1 + i_t = \beta^{-1} \frac{\tilde{u}_c(Y_t - G_t; \xi_t) P_t^{-1}}{E_t[\tilde{u}_c(Y_{t+1} - G_{t+1}; \xi_{t+1}) P_{t+1}^{-1}]}$$

- Zero bound (3):

$$i_t \geq 0$$

Public Debt

- Riskless nominal one-period bonds B_t

$$B_t = (1 + i_{t-1})B_{t-1} + P_t s_t$$

$$s_t \equiv \tau_t Y_t - G_t - \zeta_t$$

- Intertemporal Solvency Condition (4) :

$$b_{t-1}\frac{P_{t-1}}{P_t} = E_t \sum_{T=t}^{\infty} R_{t,T} s_T$$

$$R_{t,T} \equiv Q_{t,T} P_T / P_t$$

Linear-Quadratic Approximation

- Optimal policy: Minimize Loss Function

$$E_{t_0} \sum_{t=t_0}^{\infty} \beta^{t-t_0} \left\{ \frac{1}{2} q_\pi \pi_t^2 + \frac{1}{2} q_y (\hat{Y}_t - \hat{Y}_t^*)^2 \right\}$$

- It is desirable to stabilize both inflation and the welfare-relevant output gap

Aggregate Supply

$$\pi_t = \kappa[y_t + \psi(\hat{\tau}_t - \hat{\tau}_t^*)] + \beta E_t \pi_{t+1}$$

$$\kappa \equiv \frac{(1-\alpha\beta)(1-\alpha)}{\alpha}\frac{\omega+\sigma^{-1}}{1+\omega\theta} > 0$$

$$\psi \equiv \frac{1}{1-\bar{\tau}}\frac{1}{\omega+\sigma^{-1}} > 0.$$

$$\hat{\tau}_t^* \equiv -\psi^{-1}u_t$$

The Intertemporal Budget Constraint

$$\hat{b}_{t-1} - s_b\pi_t - s_b\sigma^{-1}y_t =$$

$$-f_t + E_t\sum_{T=t}^{\infty}\beta^{T-t}[b_y y_T + b_\tau(\hat{\tau}_T - \hat{\tau}_T^*)]$$

- f_t: compositve measure of exogenous 'fiscal stress' (a measure of how stabilization is consistent with government solvency)

The IS Equation

- Log linearizing the Euler equation for optimal expenditure:

$$y_t = E_t y_{t+1} - \sigma(i_t - E_t \pi_{t+1} - r_t^n),$$

$$r_t^n \equiv \bar{r} + \sigma^{-1}[(g_t - \hat{Y}_t^*) - E_t(g_{t+1} - \hat{Y}_{t+1}^*)]$$

- Natural rate of interest r_t^n depends only on exogenous real disturbances

- Additional constraint implied by the zero bound:

$$y_t \leq E_t y_{t+1} + \sigma(r_t^n + E_t \pi_{t+1})$$

Event: Large Drop in Natural Rate of Interest

- r_t^n becomes negative, IS curve shifts down
- Nominal Interest Rate i_t cannot adjust below zero to offset negative effect
- Zero bound on nominal interest rate binds

Baseline Case

- Assume zero initial public debt, government purchases and steady state tax rate. Then the intertemporal budget condition becomes:

$$\hat{b}_{t-1} = E_t \sum_{T=t}^{\infty} \beta^{T-t} \hat{\tau}_T.$$

The Optimal Paths

- Choose inflation, output gap, tax and debt paths so as to minimize:

$$\mathcal{L}_{t_0} = E_{t_0} \sum_{t=t_0}^{\infty} \beta^{t-t_0} \{ \frac{1}{2} q_\pi \pi_t^2 + \frac{1}{2} q_y y_t^2$$

$$\varphi_{1t}[y_t - y_{t+1} - \sigma \pi_{t+1}] + \varphi_{2t}[\pi_t - \kappa(y_t + \psi \hat{\tau}_t) - \beta \pi_{t+1}]$$

$$+\varphi_{3t}[\hat{b}_{t-1} - \hat{\tau}_t - \beta \hat{b}_t]\} - [\beta^{-1} \sigma \varphi_{1,t_0-1} + \varphi_{2,t_0-1}] \pi_{t_0}$$

$$- \beta^{-1} \varphi_{1,t_0-1} y_{t_0}$$

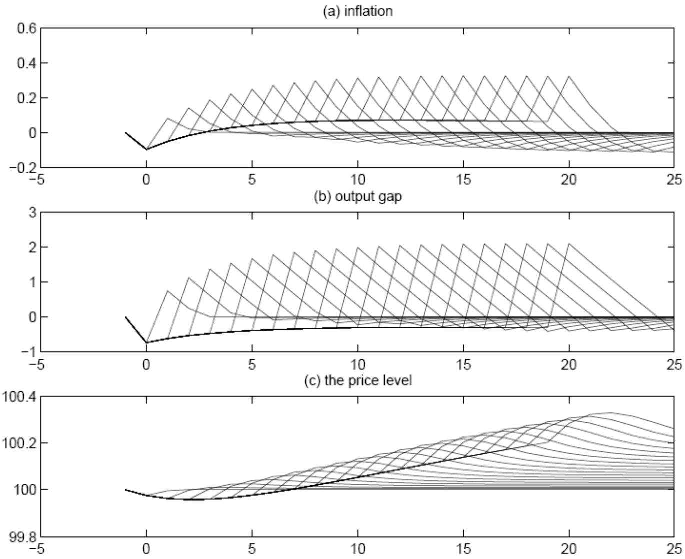
Optimal Monetary Policy if NO Fiscal Policy is Available

- No Fiscal Policy: then we have additional constraint that τ_t is a fixed constant
- Fiscal consequences (such as distortions in government revenues) of monetary policy are ignored
- Once $i_t = 0$, only power of monetary policy is to influence inflation expectations $E_t \pi_{t+1}$
- Causing high $E_t \pi_{t+1}$ shifts IS and AS curves up
- Problem: how to increase $E_t \pi_{t+1}$ via monetary policy

The Optimal Monetary Policy Commitment

- Optimal policy is to commit such that $i_t = 0$ when real shock hits
- Central bank must commit to low interest rates even AFTER negative shock is gone
- Then via IS curve, $E_t y_{t+1}$ stays high -> $E_t \pi_{t+1}$ stays high from AS curve
- Therefore, central bank can cause $E_t \pi_{t+1}$ high via commitment to low interest rates
- Optimal policy is therefore **history dependent**

The Optmal History-Dependent Monetary Policy



Adding Fiscal Policy

- Fiscal Policy: τ_t becomes a policy variable
- Introduce a distorting tax τ_t (a VAT) as the only source of government revenue
- Changing τ_t allows the central bank to shift the AS curve
- Shifting AS curve directly changes π_t and $E_t \pi_{t+1}$ associated with a given level of y_t
- Causing high $E_t \pi_{t+1}$ shifts IS and AS curves up

The Optimal Paths

- Choose inflation, output gap, tax and debt paths so as to minimize:

$$\mathcal{L}_{t_0} \;=\; E_{t_0} \sum_{t=t_0}^{\infty} \beta^{t-t_0} \{ \frac{1}{2} q_\pi \pi_t^2 + \frac{1}{2} q_y y_t^2$$

$$\varphi_{1t}[y_t - y_{t+1} - \sigma \pi_{t+1}] + \varphi_{2t}[\pi_t - \kappa(y_t + \psi \hat{\tau}_t) - \beta \pi_{t+1}]$$

$$+\varphi_{3t}[\hat{b}_{t-1} - \hat{\tau}_t - \beta \hat{b}_t]\} - [\beta^{-1} \sigma \varphi_{1,t_0-1} + \varphi_{2,t_0-1}] \pi_{t_0}$$

$$-\beta^{-1} \varphi_{1,t_0-1} y_{t_0}$$

First Order Conditions

- With respect to inflation, output gap and the tax rate:

$$q_\pi \pi_t - \beta^{-1}\sigma\varphi_{1,t-1} + \varphi_{2t} - \varphi_{2,t-1} = 0,$$

$$q_y y_t + \varphi_{1t} - \beta^{-1}\varphi_{1,t-1} - \kappa\varphi_{2t} = 0,$$

$$\kappa\psi\varphi_{2t} + \varphi_{3t} = 0,$$

$$\varphi_{3t} = E_t\varphi_{3,t+1}$$

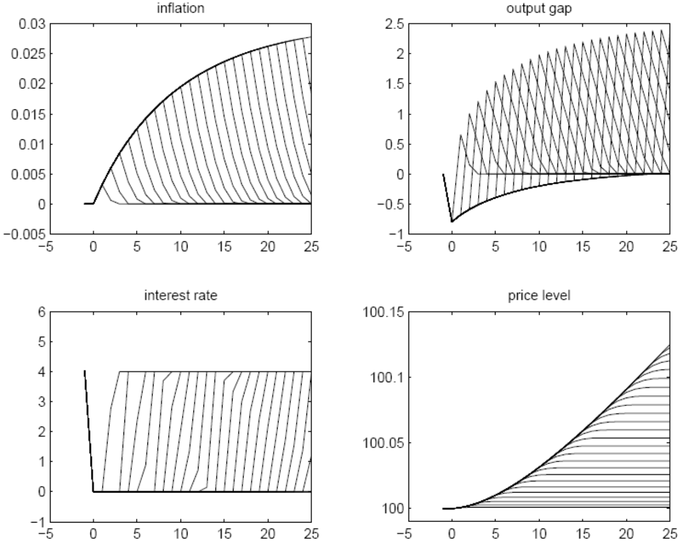
Optimal Fiscal Policy

- **Increase tax rate τ_t as soon as r_t^n turns negative**
- This shifts up the AS curve -> increases π_t and $E_t\pi_{t+1}$
- Then IS curve shifts up -> y_t increases
- **Decrease tax rate τ_t as soon as r_t^n turns positive**
- This brings down $E_t\pi_{t+1}$ once the zero bound is no longer binding

Optimal Monetary Policy

- Now there is NO need to count on monetary policy commitment to keep $E_t \pi_{t+1}$ high since Fiscal policy completely fixes the zero bound problem
- Same optimal monetary policy as in 'no fiscal policy' case above
- Optimal to keep i_t low even AFTER r_t^n turns positive, in order to avoid adverse effect on $E_t \pi_{t+1}$
- **Note the change in the role of monetary policy compared to the case above!!!**

The Optimal History Dependent Policy Outcome



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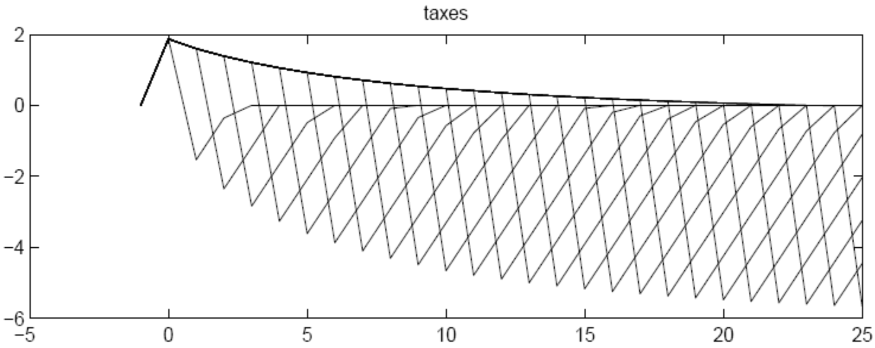
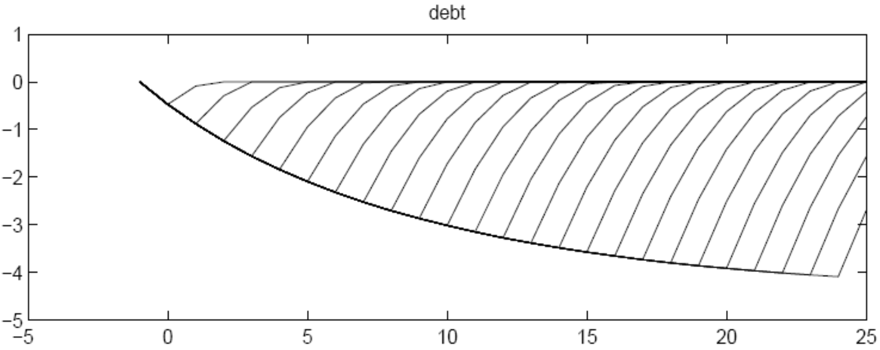


The Optimal History Dependent Policy Outcome



Summary: Optimal Monetary and Fiscal Policy with the Zero Bound

- **Monetary Policy:**
  1. Set $i_t = 0$ when r_t^n turns negative
  2. Keep i_t low even after r_t^n turns positive
- **Fiscal Policy:**
  1. Increase τ_t when r_t^n turns negative
  2. Decrease τ_t when r_t^n turns positive

The Importance of Monetary Policy with the Zero Bound

- **If there is no fiscal policy:**
- Commitment to history-dependent monetary policy is important to counteract negative shock to inflation and output
- Significant Welfare Gains from History-Dependent monetary policy
- **If there is fiscal policy:**
- Fiscal Policy can effectively counteract the negative shock to the natural rate
- Monetary Policy is important to keep expectations 'under control'
- Welfare gains from monetary policy are modest when optimal fiscal policy is used
- **Fiscal policy is more effective and easier to implement as a solution to the zero bound problem**