Monetary Policy and the Open Economy

by

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Motivation

- The basic new Keynesian model for the closed economy

  - equilibrium dynamics: simple three-equation representation
  - ability to match much of the evidence on the effects of monetary policy and technology shocks
  - monetary policy: optimality of inflation targeting

- How does the introduction of open economy elements affect that analysis and prescriptions?
- What role should the exchange rate play in the design of policy? What is the optimal degree of exchange rate volatility?
- Issue: many possible combinations of assumptions on size, market completeness, pass-through, etc.

A Baseline New Keynesian Model of the Small Open Economy (Galí 2015, GM 2005)

Households

Representative household maximizing

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, N_t; Z_t)$$

where

$$C_t \equiv \left((1-\upsilon)^{\frac{1}{\eta}} {C_{H,t}}^{1-\frac{1}{\eta}} + \upsilon^{\frac{1}{\eta}} {C_{F,t}}^{1-\frac{1}{\eta}} \right)^{\frac{\eta}{\eta-1}}$$

$$C_{H,t} \equiv \left(\int_0^1 C_{H,t}(i)^{\frac{\epsilon-1}{\epsilon}} di \right)^{\frac{\epsilon}{\epsilon-1}}$$

subject to

$$\int_0^1 P_{H,t}(i) C_{H,t}(i) di + P_{F,t} C_{F,t} + E_t\{Q_{t,t+1} D_{t+1}\} \leq D_t + W_t N_t$$

Assumption:

$$U(C_t, N_t; Z_t) = \begin{cases} \left(\frac{C_t^{1-\sigma}-1}{1-\sigma} - \frac{N_t^{1+\varphi}}{1+\varphi} \right) Z_t & \text{for } \sigma \neq 1 \\ \left(\log C_t - \frac{N_t^{1+\varphi}}{1+\varphi} \right) Z_t & \text{for } \sigma = 1 \end{cases}$$

with $z_t \equiv \log Z_t = \rho_z z_{t-1} + \varepsilon_t^z$

- *Optimal allocation of expenditures*

(i) Domestic goods:

$$C_{H,t}(i) = \left(\frac{P_{H,t}(i)}{P_{H,t}}\right)^{-\epsilon} C_{H,t} \tag{1}$$

for all $i \in [0,1]$, where $P_{H,t} \equiv \left(\int_0^1 P_{H,t}(i)^{1-\epsilon} di\right)^{\frac{1}{1-\epsilon}}$

$$\Rightarrow \int_0^1 P_{H,t}(i) C_{H,t}(i) \; di = P_{H,t} C_{H,t}$$

(ii) Domestic vs. Foreign

$$C_{H,t} = (1-\upsilon)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t \qquad ; \qquad C_{F,t} = \upsilon\left(\frac{P_{F,t}}{P_t}\right)^{-\eta} C_t \tag{2}$$

where $P_t \equiv \left[(1-\upsilon)(P_{H,t})^{1-\eta} + \upsilon(P_{F,t})^{1-\eta}\right]^{\frac{1}{1-\eta}}$

$$\Rightarrow P_{H,t} C_{H,t} + P_{F,t} C_{F,t} = P_t C_t$$

- Other optimality conditions

$$Q_{t,t+1} = \beta \left(\frac{C_{t+1}}{C_t}\right)^{-\sigma} \left(\frac{Z_{t+1}}{Z_t}\right) \left(\frac{P_t}{P_{t+1}}\right)$$

$$Q_t = E_t\{Q_{t,t+1}\} = \beta E_t \left\{ \left(\frac{C_{t+1}}{C_t}\right)^{-\sigma} \left(\frac{Z_{t+1}}{Z_t}\right) \left(\frac{P_t}{P_{t+1}}\right) \right\}$$

$$C_t^{\sigma} N_t^{\varphi} = \frac{W_t}{P_t}$$

- Some definitions and identities

Terms of trade:

$$s_t \equiv \log \mathcal{S}_t = p_{F,t} - p_{H,t}$$

CPI:

$$\begin{aligned} p_t &= (1-\upsilon)p_{H,t} + \upsilon p_{F,t} \\ &= p_{H,t} + \upsilon s_t \end{aligned}$$

CPI vs. Domestic inflation:

$$\pi_t = \pi_{H,t} + \upsilon \Delta s_t$$

where $\pi_{H,t} \equiv p_{H,t} - p_{H,t-1}$

- Law of one price

$$p_{F,t} = e_t + p_t^*$$

- Real exchange rate

$$\begin{aligned} q_t &\equiv p_{F,t} - p_t \\ &= s_t + p_{H,t} - p_t \\ &= (1-\upsilon)s_t \end{aligned}$$

- International risk sharing

$$\beta \left(\frac{C^*_{t+1}}{C^*_t} \right)^{-\sigma} \left(\frac{P^*_t}{P^*_{t+1}} \right) \left(\frac{\mathcal{E}_t}{\mathcal{E}_{t+1}} \right) = Q_{t,t+1}$$

$$\Rightarrow C_t = \vartheta C^*_t Z_t^{\frac{1}{\sigma}} \mathcal{Q}_t^{\frac{1}{\sigma}}$$

$$\begin{aligned} c_t &= y^*_t + \frac{1}{\sigma}(z_t + q_t) \\ &= y^*_t + \frac{1}{\sigma} z_t + \left(\frac{1-\upsilon}{\sigma} \right) s_t \end{aligned}$$

given $c^*_t = y^*_t$

Firms

- Technology

$$Y_t(i) = A_t N_t(i)^{1-\alpha}$$

where $a_t \equiv \log A_t = \rho_a a_{t-1} + \varepsilon_t^a$.

- Optimal price setting

$$\overline{p}_{H,t} = \mu + (1-\beta\theta) \sum_{k=0}^{\infty} (\beta\theta)^k E_t\{\psi_{t+k|t}\}$$

- Domestic inflation dynamics

$$\pi_{H,t} = \beta E_t\{\pi_{H,t+1}\} - \lambda \widehat{\mu}_t$$

where $\widehat{\mu}_t \equiv p_{H,t} - \psi_{t+k} - \mu$ and $\lambda \equiv \frac{(1-\theta)(1-\beta\theta)}{\theta} \frac{1-\alpha}{1-\alpha+\alpha\epsilon}$

Exports

$$X_t(i) = \left(\frac{P_{H,t}(i)}{P_{H,t}} \right)^{-\epsilon} X_t$$

where $X_t \equiv \left(\int_0^1 X_t(i)^{\frac{\epsilon-1}{\epsilon}} di \right)^{\frac{\epsilon}{\epsilon-1}}$ given by

$$\begin{aligned} X_t &= \upsilon \left(\frac{P_{H,t}}{\mathcal{E}_t P_t^*} \right)^{-\eta} Y_t^* \\ &= \upsilon \mathcal{S}^{\eta} Y_t^* \end{aligned}$$

Equilibrium

- Goods market clearing

$$\begin{aligned} Y_t(i) &= C_{H,t}(i) + X_t(i) \\ &= \left(\frac{P_{H,t}(i)}{P_{H,t}}\right)^{-\epsilon} \left[(1-\upsilon)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t + \upsilon \mathcal{S}^{\eta} Y_t^*\right] \end{aligned}$$

for all $i \in [0,1]$ and all t. Combined with $Y_t \equiv \left(\int_0^1 Y_t(i)^{1-\frac{1}{\epsilon}} di\right)^{\frac{\epsilon}{\epsilon-1}}$

$$Y_t = (1-\upsilon)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t + \upsilon \mathcal{S}_t^{\eta} Y_t^*$$

Log-linearized version:

$$y_t = (1-\upsilon)c_t + \upsilon(2-\upsilon)\eta s_t + \upsilon y_t^*$$

Euler equation (in terms of $\pi_{H,t+1}$):

$$c_t = E_t\{c_{t+1}\} - \frac{1}{\sigma}(i_t - E_t\{\pi_{H,t+1}\} - \rho) + \frac{\upsilon}{\sigma} E_t\{\Delta s_{t+1}\} + \frac{1}{\sigma}(1-\rho_z)z_t$$

Terms of trade (using IRS condition):

$$s_t = \sigma_\upsilon(y_t - y_t^*) - (1-\upsilon)\Phi z_t$$

where $\sigma_\upsilon \equiv \sigma\Phi > 0$ with $\Phi \equiv \frac{1}{1+\upsilon(\varpi-1)} > 0$ and $\varpi \equiv \sigma\eta + (1-\upsilon)(\sigma\eta - 1)$.

Combining them all

$$\widetilde{y}_t = E_t\{\widetilde{y}_{t+1}\} - \frac{1}{\sigma_\upsilon}(i_t - E_t\{\pi_{H,t+1}\} - r_t^n)$$

where

$$r_t^n = \rho + \sigma_\upsilon E_t\{\Delta y_{t+1}^n\} + \sigma_\upsilon \upsilon(\varpi - 1)E_t\{\Delta y_{t+1}^*\} + \Phi(1-\upsilon)(1-\rho_z)z_t$$

- Labor market clearing

$$N_t \equiv \int_0^1 N_t(i)di = \left(\frac{Y_t}{A_t}\right)^{\frac{1}{1-\alpha}} \int_0^1 \left(\frac{P_{H,t}(i)}{P_{H,t}}\right)^{-\frac{\epsilon}{1-\alpha}} di$$

Up to a first-order approximation:

$$y_t = a_t + (1-\alpha)n_t$$

- Price markups and the output gap

$$\begin{aligned}
\mu_t &= p_{H,t} - (w_t - a_t + \alpha n_t) \\
&= -(w_t - p_t) - (p_t - p_{H,t}) + a_t - \alpha n_t \\
&= -(\sigma c_t + \varphi n_t) - \upsilon s_t + a_t - \alpha n_t \\
&= -\left(\sigma + \frac{\varphi + \alpha}{1-\alpha}\right) y_t + \upsilon(\varpi - 1)s_t + \left(1 + \frac{\varphi + \alpha}{1-\alpha}\right) a_t - \upsilon z_t
\end{aligned}$$

Accordingly,

$$\widehat{\mu}_t = -\left(\sigma + \frac{\varphi + \alpha}{1-\alpha}\right)\widetilde{y}_t + \upsilon(\varpi - 1)\widetilde{s}_t$$

and

$$y_t^n = \Gamma_a a_t + \Gamma_z z_t + \Gamma_* y_t^*$$
$$s_t^n = \sigma_\upsilon (y_t^n - y_t^*) - (1-\upsilon)\Phi z_t$$

with $\Gamma_a \equiv \frac{1+\varphi}{\sigma_\upsilon(1-\alpha)+\varphi+\alpha} > 0$, $\Gamma_* \equiv -\frac{\upsilon(\varpi-1)\sigma_\upsilon(1-\alpha)}{\sigma_\upsilon(1-\alpha)+\varphi+\alpha}$ and $\Gamma_z \equiv -\frac{\upsilon\varpi\Phi(1-\alpha)}{\sigma_\upsilon(1-\alpha)+\varphi+\alpha}$.

Using the fact that $\widetilde{s}_t = \sigma_\upsilon \widetilde{y}_t$,

$$\widehat{\mu}_t = -\left(\sigma_\upsilon + \frac{\varphi+\alpha}{1-\alpha}\right)\widetilde{y}_t$$
$$\pi_{H,t} = \beta E_t\{\pi_{H,t+1}\} + \kappa_\upsilon \widetilde{y}_t$$

where $\kappa_\upsilon \equiv \lambda\left(\sigma_\upsilon + \frac{\varphi+\alpha}{1-\alpha}\right)$. Also

$$r_t^n \equiv \rho - \sigma_\upsilon \Gamma_a (1-\rho_a) a_t + \Psi_* E_t\{\Delta y_{t+1}^*\} + \Psi_z (1-\rho_z) z_t$$

with $\Psi_* \equiv \sigma_\upsilon\left(\upsilon(\varpi-1) + \Gamma_*\right)$ and $\Psi_z \equiv (1-\upsilon)\Phi - \sigma_\upsilon \Gamma_z$. Note that $\lim_{\upsilon\to 0}\Psi_* = 0$ and $\lim_{\upsilon\to 0}\Psi_z = 1$.

Equilibrium Dynamics under a Taylor-type Rule

$$\pi_{H,t} = \beta E_t\{\pi_{H,t+1}\} + \kappa_\upsilon \widetilde{y}_t$$

$$\widetilde{y}_t = E_t\{\widetilde{y}_{t+1}\} - \frac{1}{\sigma_\upsilon}(i_t - E_t\{\pi_{H,t+1}\} - r_t^n)$$

$$i_t = \rho + \phi_\pi \pi_{H,t} + \phi_y \widehat{y}_t + v_t$$

where $v_t = \rho_v v_{t-1} + \varepsilon_t^v$ and $r_t^n \equiv \rho - \sigma_\upsilon \Gamma_a (1-\rho_a) a_t + \Psi_* E_t\{\Delta y_{t+1}^*\} + \Psi_z (1-\rho_z) z_t$
Equivalently

$$\begin{bmatrix} \widetilde{y}_t \\ \pi_{H,t} \end{bmatrix} = \mathbf{A}_\upsilon \begin{bmatrix} E_t\{\widetilde{y}_{t+1}\} \\ E_t\{\pi_{H,t+1}\} \end{bmatrix} + \mathbf{B}_\upsilon u_t$$

where

$$u_t \equiv \widehat{r}_t^n - \phi_y \widehat{y}_t^n - v_t$$

$$\mathbf{A}_\upsilon \equiv \Omega_\upsilon \begin{bmatrix} \sigma_\upsilon & 1-\beta\phi_\pi \\ \sigma_\upsilon \kappa_\upsilon & \kappa_\upsilon + \beta(\sigma_\upsilon + \phi_y) \end{bmatrix} \quad ; \quad \mathbf{B}_\upsilon \equiv \Omega_\upsilon \begin{bmatrix} 1 \\ \kappa_\upsilon \end{bmatrix}$$

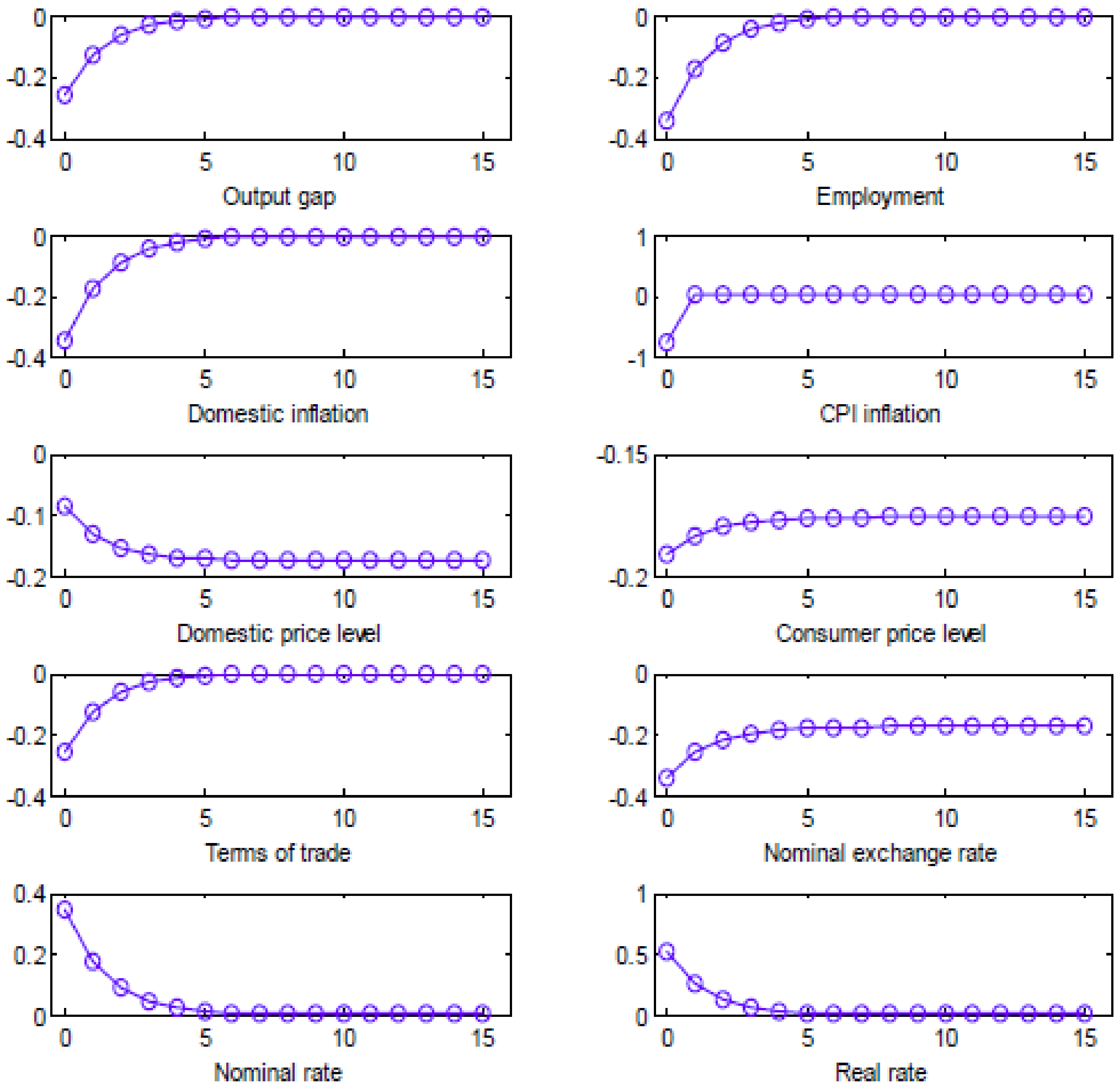
with $\Omega_\upsilon \equiv \frac{1}{\sigma_\upsilon + \phi_y + \kappa_\upsilon \phi_\pi}$.

- *Uniqueness condition*

$$\kappa_\upsilon(\phi_\pi - 1) + (1-\beta)\phi_y > 0$$

- Effects of a monetary policy shock

Dynamic responses to a monetary policy shock



Optimal Monetary Policy: A Special Case

- *Assumptions*:

$$Z_t = 1 \text{ all } t$$

$$\sigma = \eta = 1$$

- Social Planner's Problem

$$\max U(C_t, N_t; 1)$$

subject to the consumption/output possibilities set

$$C_t = Y_t^{1-\upsilon}(Y_t^*)^{\upsilon}$$

Optimal allocation

$$-\frac{U_n(C_t, N_t)}{U_c(C_t, N_t)} = (1-\upsilon)(1-\alpha)\frac{C_t}{N_t}$$

Under the assumed preferences:

$$C_t N_t^{\varphi} = (1-\upsilon)(1-\alpha)\frac{C_t}{N_t}$$

$$\Rightarrow N = [(1-\upsilon)(1-\alpha)]^{\frac{1}{1+\varphi}}$$

- Flexible price equilibrium

$$\mathcal{M} = \frac{P_{H,t}}{W_t/MPN_t} = \frac{(1-\alpha)(Y_t/N_t)}{(1-\tau)C_t N_t^{\varphi}\mathcal{S}_t^{\upsilon}} = \frac{(1-\alpha)}{(1-\tau)N_t^{1+\varphi}}$$

Optimal subsidy:

$$(1-\tau)(1-\upsilon)\mathcal{M} = 1$$

- Implementation

$$\widetilde{y}_t = \pi_{H,t} = 0$$
$$i_t = r_t^n$$

Optimal interest rate rule:

$$i_t = r_t^n + \phi_\pi \pi_{H,t}$$

- Macroeconomic implications of domestic inflation targeting

$$\begin{aligned} s_t^n &= \sigma_\upsilon (y_t^n - y_t^*) - (1-\upsilon)\Phi z_t \\ &= \sigma_\upsilon \Gamma_a a_t + \sigma_\upsilon (\Gamma_* - 1) y_t^* + [\sigma_\upsilon \Gamma_z - (1-\upsilon)\Phi] z_t \end{aligned}$$
$$e_t^{DIT} = s_t^n - p_t^*$$

$$\begin{aligned} p_t^{DIT} &= \upsilon s_t^n \\ &= \upsilon (e_t^{DIT} + p_t^*) \end{aligned}$$

Evaluation of Alternative Policies

- Welfare losses (under special case)

$$\mathbb{W} = \frac{(1-\upsilon)}{2} \sum_{t=0}^{\infty} \beta^t \left(\left(\frac{1+\varphi}{1-\alpha} \right) \widetilde{y}_t^2 + \frac{\epsilon}{\lambda} \pi_{H,t}^2 \right)$$

$$\mathbb{V} = \frac{(1-\upsilon)}{2} \left[\left(\frac{1+\varphi}{1-\alpha} \right) var(\widetilde{y}_t) + \frac{\epsilon}{\lambda}\ var(\pi_{H,t}) \right]$$

- Four suboptimal rules

$$\pi_t = 0$$

$$e_t = 0$$

$$i_t = 0.01 + 1.5\pi_{H,t} + 0.125\widehat{y}_t$$

$$i_t = 0.01 + 1.5\pi_t + 0.125\widehat{y}_t$$

Table 8.1 Properties of Simple Policy Rules

	SDIT	*SCIT*	PEG	*FDIT*	*FCIT*
$\sigma(y)$	2.29	1.92	1.72	1.85	1.76
$\sigma(\widetilde{y})$	0	0.66	0.92	0.44	0.62
$\sigma(\pi_H)$	0	0.19	0.35	0.69	0.58
$\sigma(\pi)$	0.41	0	0.21	0.70	0.52
$\sigma(s)$	2.29	1.92	1.72	1.85	1.76
$\sigma(\Delta e)$	1.02	0.29	0	0.95	0.59
$\mathbb{L}$	0	0.05	0.17	0.61	0.43