The exam consists of four parts: A, B, C, and D. In the grading, part A has 10% weight, part B has 20% weight, part C has 45% weight, and part D has 25% weight. Allocate your time accordingly.

# Part A: Short questions on Macroprudential policy (10%)

Write short answers to these questions (1-2 paragraphs).

**a)** Explain why banks' behavior could be pro-cyclical.

**b)** What is macroprudential policy?

# Part B: The household problem (20%)

Assume that the problem the representative household solves is:

$$\max_{\{C_t, N_t, B_t\}_{t=0}^{\infty}} \mathbb{E}_t \sum_{k=0}^{\infty} \beta^k \left( \frac{C_t^{1-\sigma} - 1}{1-\sigma} - \frac{N_t^{1+\phi}}{1+\phi} \right) \tag{1}$$

subject to

$$P_t C_t + \frac{B_t}{1+i_t} \leq B_{t-1} + W_t N_t + D_t \tag{2}$$

$$\lim_{T \to \infty} \mathbb{E}_t \left\{ \beta^{T-t} \frac{U_{C,T}}{U_{C,t}} \frac{B_T}{P_T} \right\} \geq 0 \tag{3}$$

where $C_t$ is consumption, $N_t$ is hours worked, $B_t$ is nominal bonds, $P_t$ is the price of consumption goods, $i_t$ is the nominal interest rate, $W_t$ is the nominal wage, $D_t$ is nominal dividends from firms, $\beta \in [0, 1)$ is the discount rate, $\sigma > 0$ is a parameter, and $\phi > 0$ is a parameter.

**a)** Solve the problem and show that the first-order conditions can be written as

$$C_t^{-\sigma} \frac{W_t}{P_t} = N_t^{\phi} \tag{4}$$

$$C_t^{-\sigma} = \beta(1+i_t) \mathbb{E}_t \left\{ C_{t+1}^{-\sigma} \frac{P_t}{P_{t+1}} \right\} \tag{5}$$

**b)** Interpret equation (4) and (5). What are the trade-offs involved for the household?

**c)** Log-linearize equation (4).

# Part C: Optimal monetary policy (45%)

We will use the New Keynesian model to see how the economy responds to a cost-push shock under optimal monetary policy. The model is

$$\pi_t = \beta E_t\{\pi_{t+1}\} + \kappa x_t + u_t \tag{6}$$
$$x_t = E_t\{x_{t+1}\} - (i_t - E_t\{\pi_{t+1}\}) \tag{7}$$
$$u_t = \rho u_{t-1} + \varepsilon_t^u \tag{8}$$
$$\varepsilon_t^u \sim N(0, \sigma_u) \tag{9}$$

where $x$ is the output gap, $\pi$ is inflation, $i$ is the nominal interest rate, $u$ is a cost-push shock, and $\varepsilon^u$ is an innovation to the cost-push process. $\kappa > 0$, $\beta \in [0, 1)$, $\rho \in [0, 1)$, and $\sigma_u > 0$ are parameters. Assume further that the central bank minimizes this loss function:

$$L_t = \frac{1}{2}\mathbb{E}_t \sum_{k=0}^{\infty} \beta^k [\lambda x_{t+k}^2 + \pi_{t+k}^2] \tag{10}$$

with $\lambda \geq 0$.

**a)** Solve for optimal monetary policy under **discretion** and show that the first-order conditions can be written as

$$x_{t+k} = -\frac{\kappa}{\lambda}\pi_{t+k} \quad \text{for} \quad k \geq 0. \tag{11}$$

**b)** Interpret equation (11). Which trade-off does the central bank face?

**c)** Show that $\pi_t$ and $x_t$ can be written as functions of the cost-push shocks:

$$\pi_t = \frac{\lambda}{\kappa^2 + \lambda(1 - \beta\rho)} u_t,$$
$$x_t = -\frac{\kappa}{\kappa^2 + \lambda(1 - \beta\rho)} u_t.$$

**d)** Assume that the central bank commits to a response function of the following form

$$x_t = -\omega u_t. \tag{12}$$

Show that the Phillips curve in this case can be written as

$$(1 - \beta\rho)\pi_t = \kappa x_t + u_t.$$

**e)** Solve for optimal monetary policy under commitment to the simple rule (12) and show that the condition is

$$x_{t+k} = -\frac{\kappa}{\lambda(1-\beta\rho)}\pi_{t+k} \quad \text{for} \quad k \geq 0. \tag{13}$$

**f)** Interpret equation (13). Compare the solution under an optimal simple rule (13) with the solution under discretion (11). Why do the two solutions differ? What are the gains from commitment?

**g)** Figure 1 shows how the output gap, inflation, the nominal interest rate, and the real interest rate respond to a positive cost-push shock under discretion and under commitment to a simple rule. Which line (solid or dashed) corresponds to which type of monetary policy (discretion or commitment)? Explain your answer.

Hint: The calibration is $\beta = 0.99$, $\kappa = 0.2$, $\lambda = 0.3$, and $\rho = 0.75$ (this is not strictly necessary to answer this problem but might help to interpret what is going on).

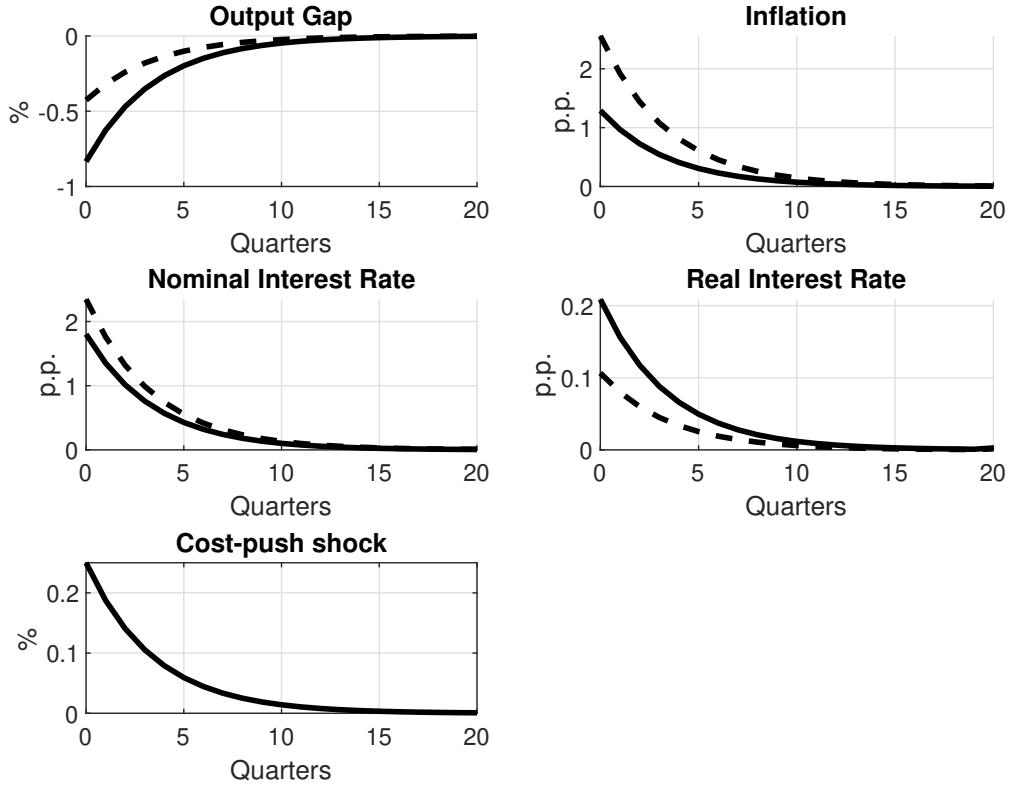



**Figure 1:** Discretion vs. Optimal Simple Rule: Impulse Responses to a Cost-Push Shock.

# Part D: Monetary and fiscal policy in an open economy (25%)

Assume a small open economy model and that global market prices ($\pi^*$) and interest rates ($r^*$) are exogenous variables. The macroeconomic policy consists of setting the interest rate ($r$, monetary policy) and determining the size of public expenditures ($g$, fiscal policy). The optimal response of monetary and fiscal policy to shocks ($u$, $z$, $v$) are

$$r = \frac{1}{\gamma_2}[(\pi^e - \pi^*) + u] + (e^e + r^* + z), \tag{14}$$

$$g = -\frac{1}{\alpha_3}v + \frac{\alpha_1 + \alpha_2}{\alpha_3\gamma_2}[(\pi^e - \pi^*) + u] + \frac{\alpha_1}{\alpha_3}(e^e + r^* + z) \tag{15}$$

where $\pi^e$ is inflation expectation, $\pi^*$ is the inflation target, $y$ is the output gap, $e^e$ is the expected exchange rate, $v$ is a demand shock, $u$ is an inflation shock, and $z$ is a risk premium shock. All parameters ($\gamma_2$, $\alpha_1$, $\alpha_2$, and $\alpha_3$) are positive.

**a)** Discuss how monetary and fiscal policy should react to

(i) a negative demand shock ($v$)

(ii) a negative inflation shock ($u$)

(iii) an increase in foreign interest rates ($r^*$)

**b)** What does the analysis in (a) tell you about the interaction between monetary and fiscal policy?

**c)** Explain the Tinbergen rule.