The exam consists of three parts, A, B, and C. In the grading, Part A has 20% weight, Part B has 30% weight, and Part C has 50% weight. Remember to allocate your time accordingly.

Part A (20 %)

This part contains two problems. You need to answer all to get full score. Your answers to each problem should not exceed one page.

a) **Balance sheet policies.** Explain how the central bank can use its balance sheet as a monetary policy tool to stimulate the economy. How effective is this type of policy?

b) **Log-linearization.** Log linearize the following equation around k and z.

$$k_{t+1} = sz_t k_t^{\alpha} + (1 - \delta)k_t.$$

Part B (30%)

This part contains three problems. You need to answer all to get full score.

The household problem in the standard New-Keynesian model is

$$\max_{C_t, N_t} E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\sigma} - 1}{1-\sigma} - \frac{N_t^{1+\phi}}{1+\phi} \right)$$

subject to

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

$$\lim_{T\to\infty} E_t \left\{ \beta^{T-t} \frac{U_{C,T}}{U_{C,t}} \frac{B_T}{P_T} \right\} \geq 0$$

where C is consumption, N is labor supply, B is a nominal bond, W is the nominal wage, D is dividends, P is the price of consumer goods, and i is the nominal interest rate.

a) **The Euler equation.** Solve the household problem and find the expression for the intertemporal consumption Euler equation. Explain the intuition. What trade-off does the household face? Which factors influence this decision?

b) **Consumption-labor.** Solve the household problem and find the expression for the intratemporal consumption-labor decision. Explain the intuition. What trade-off does the household face? Which factors influence this decision?

c) **GHH preferences.** Assume that the utility function instead is

$$U(C_t, N_t) = \log \left(C_t - \frac{N_t^{1+\phi}}{1+\phi} \right).$$

Solve for the *intratemporal consumption-labor choice*. Explain how the solution is different from b). Which channel is absent from the solution in c) compared to the solution in b).

Part C (50 %)

This part contains five problems. You need to answer all to get full score.

We are going to use the New Keynesian model to see how the economy responds to a discount rate shock under an interest rate rule. Assume that the model is

$$\pi_t = \beta E_t\{\pi_{t+1}\} + \kappa \tilde{y}_t + u_t \tag{1}$$

$$y_t = E_t\{y_{t+1}\} - (i_t - E_t\{\pi_{t+1}\}) \tag{2}$$

$$i_t = \phi_\pi \pi_t \tag{3}$$

$$u_t = \rho_u u_{t-1} + \nu_t^u, \qquad \nu_t^u \sim N(0, \sigma_u) \tag{4}$$

$$\kappa = \left(1 + \frac{\phi + \alpha}{1 - \alpha}\right)\left(\frac{1-\theta}{\theta}\right)(1 - \beta\theta)\left(\frac{1-\alpha}{1 - \alpha + \alpha\varepsilon}\right) \tag{5}$$

where π is inflation, y is the output gap, and u is a cost-push shock. β, κ, ϕ_π, ρ_u, σ_u, ϕ, α, θ, and ε are parameters of the model.

a) **Guess and verify.** Guess that

$$x_t = \psi_{xu} u_t$$
$$\pi_t = \psi_{\pi u} u_t$$
$$E_t\{x_{t+1}\} = \rho \psi_{xu} u_t$$
$$E_t\{\pi_{t+1}\} = \rho \psi_{\pi u} u_t.$$

Find the solutions for ψ_{xu} and $\psi_{\pi u}$.

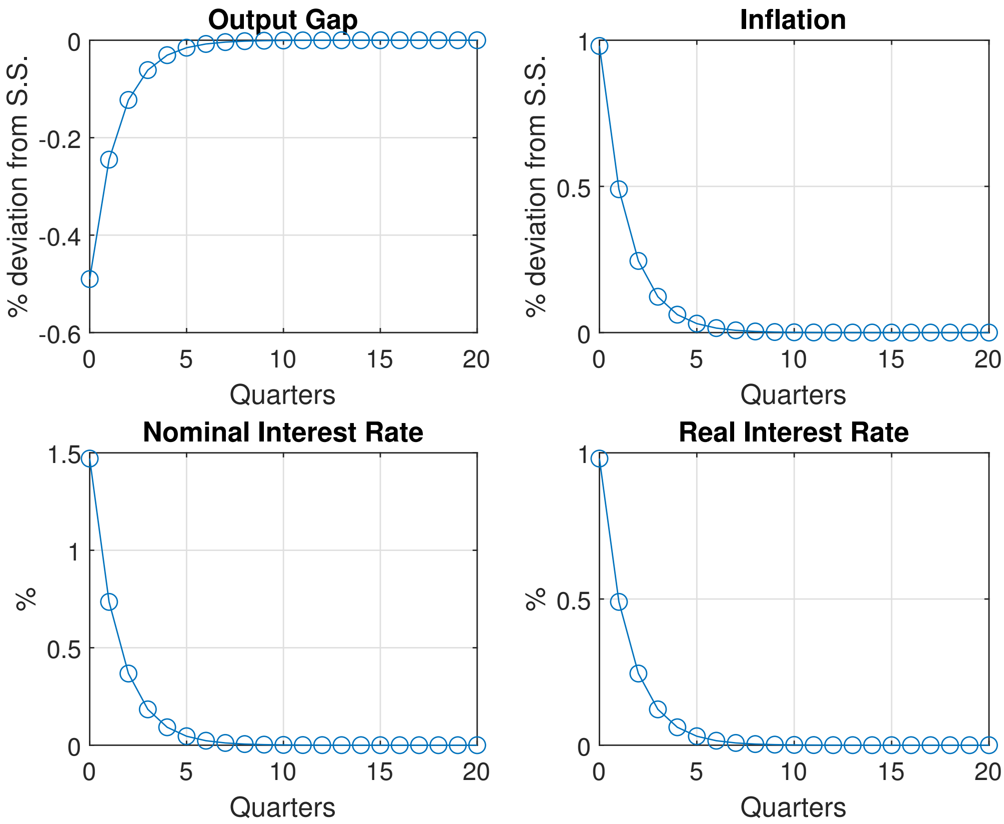

Figure 1: Impulse Responses

b) **Impulse responses.** Figure 1 shows the impulse responses of the output gap, inflation, the nominal interest rate, and the real interest rate to a positive cost-push shock. The calibration is as follows: $\beta = 0.99$, $\phi = 5$, $\alpha = 0.25$, $\varepsilon = 9$, $\theta = 0.75$, $\phi_\pi = 1.5$, and $\rho_u = 0.5$. Explain in words how the cost-push shock affects the economy and how the central bank responds to it.

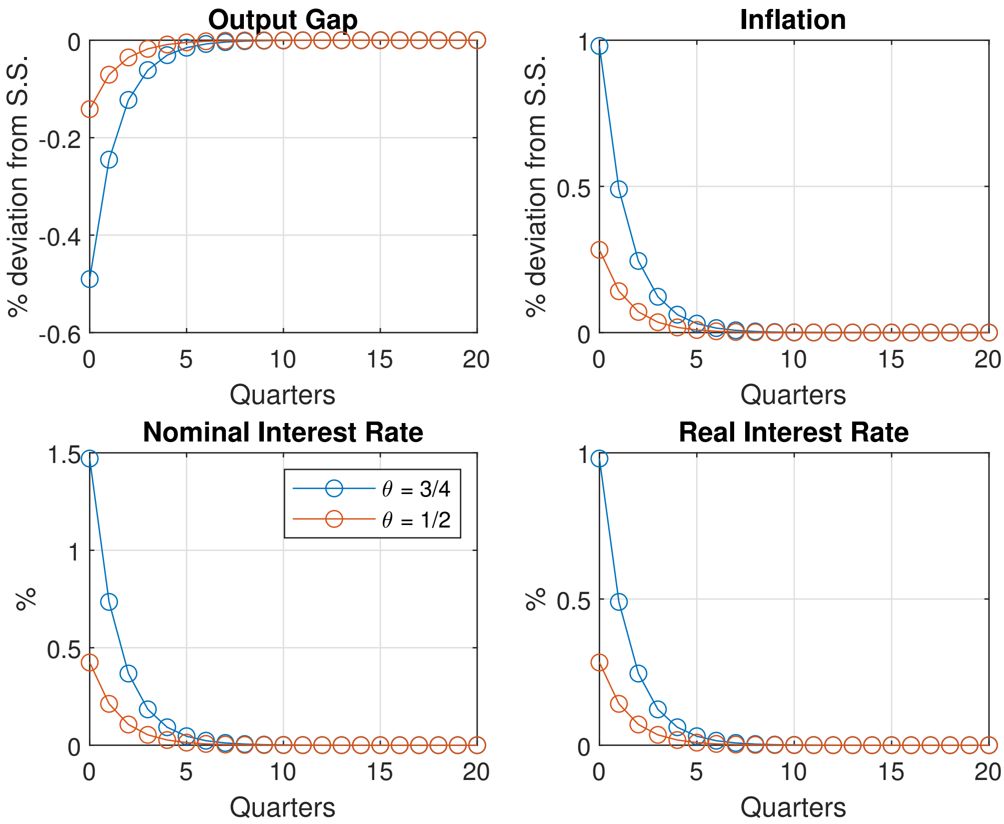

Figure 2: Impulse Responses

c) **Parameter changes.** We now reduce θ from 0.75 to 0.50. All other parameters are the same as in problem b). Figure 2 presents the impulse responses in the benchmark scenario and in the new calibration. Explain what θ is, how it changes the economic environment, and explain how agents alter their behavior. Next, explain why the aggregate responses of the economy change in the way presented in Figure 2.

d) **Optimal monetary policy.** We are now going to solve for optimal monetary policy under commitment (unconstrained optimum). Assume that the central bank minimizes the following loss function

$$\mathcal{L} = \frac{1}{2}\mathbb{E}_t \sum_{k=0}^{\infty} \beta^k (\lambda y_{t+k}^2 + \pi_{t+k}^2) \tag{6}$$

where $\lambda > 0$. Minimize the loss function (6) subject to the Phillips curve (1) under commitment. What is the trade-off the central bank faces?