The exam consists of two parts, A and B, with equal weight in the grading (50% each). Remember to allocate your time accordingly.

Part A (50 %)

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

a) **Norges Bank case.**

Figure 1 shows Norges Bank's decomposition of changes in the rate path in the Monetary Policy Report 1/2022. Choose three of the six factors and explain what has happened since the last meeting and the channels through which the channels have contributed to change the interest rate path.

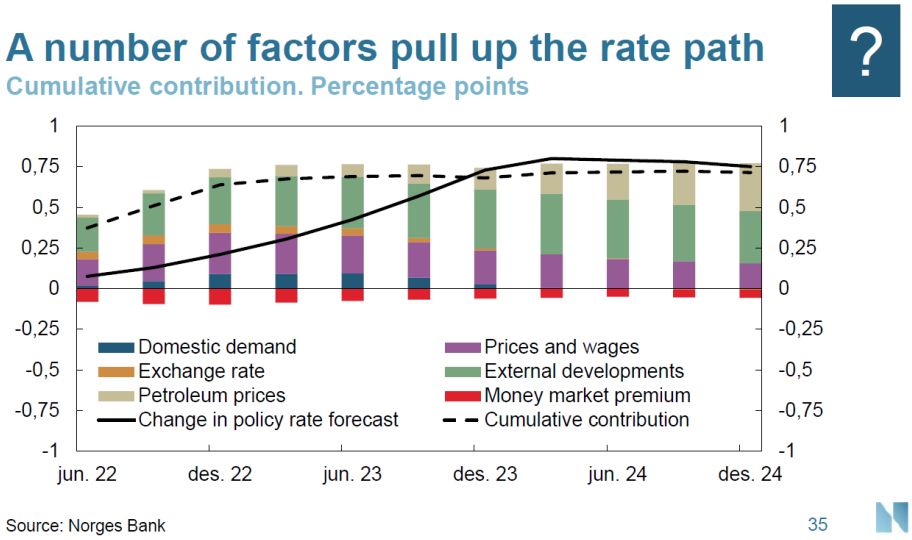


Figure 1: Norges Bank's decomposition of changes in the rate path

b) **Log-linearization.**

Log-linearize $Y_t = A_t L_t^{1-\alpha}$ and $Y_t = C_t + I_t$.

c) **Liquidity trap.**

Briefly explain what characterizes a liquidity trap.

d) **Balance sheet policies.**

Explain how the central bank can use its balance sheet as a monetary policy tool, why these tools should provide monetary stimulus, and what we know about its effectiveness.

e) **Negative interest rates.**

Suppose the central bank policy rate is zero, but the economy still has a negative output gap and inflation below the target. The Governor of the central bank now asks you whether you think the policy rate should be set below zero. Discuss the existing empirical evidence on how effective policy rate cuts below zero can be in terms of stimulating the economy through the banking system, i.e., in terms of lowering deposit and lending rates.

Part B (50 %)

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. We assume that the model is

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

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

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

$$z_t = \rho_z z_{t-1} + \nu_t^z, \qquad \nu_t^z \sim N(0, \sigma_z) \tag{4}$$

$$u_t = \rho_u u_{t-1} + \nu_t^u, \qquad \nu_t^u \sim N(0, \sigma_u) \tag{5}$$

$$\kappa = \left(1 + \frac{\phi + \alpha}{1 - \alpha}\right)\left(\frac{1 - \theta}{\theta}\right)(1 - \beta\theta)\left(\frac{1 - \alpha}{1 - \alpha + \alpha\varepsilon}\right) \tag{6}$$

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

a) **Guess and verify.**

Find the model solution for the discount rate shock. Guess that

$$y_t = \psi_{yz} z_t, \quad E_t\{y_{t+1}\} = \rho_z \psi_{yz} z_t,$$
$$\pi_t = \psi_{\pi z} z_t, \quad E_t\{\pi_{t+1}\} = \rho_z \psi_{\pi z} z_t,$$

and show that

$$\psi_{yz} = (1 - \beta\rho_z)\Lambda_z,$$
$$\psi_{\pi z} = \kappa \Lambda_z,$$
$$\Lambda_z = \frac{1}{(1 - \beta\rho_z)(1 - \rho_z) + \kappa(\phi_\pi - \rho_z)}.$$

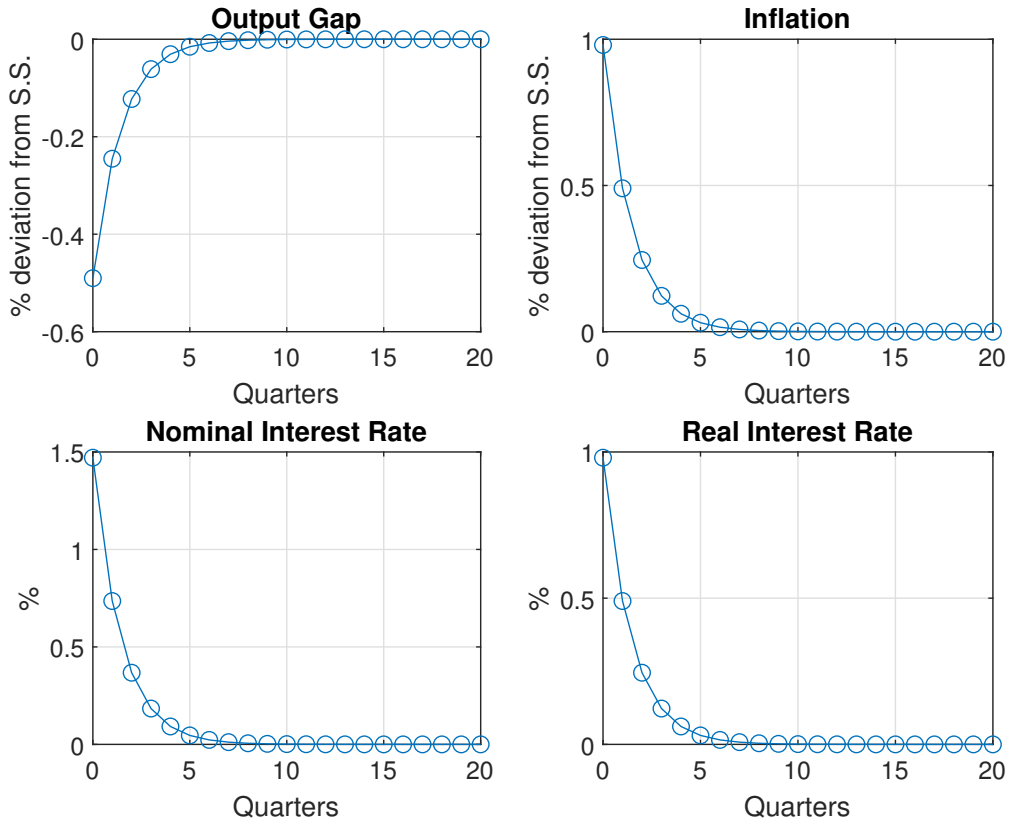


Figure 2: Impulse Responses

b) **Interpretation of impulse responses.**

Figure 2 shows the impulse responses of the output gap, inflation, the nominal interest rate, and the real interest rate to an initial shock to either ν_0^z or ν_0^u (only one of them). The calibration is as follows: $\beta = 0.99$, $\phi = 5$, $\alpha = 0.25$, $\varepsilon = 9$, $\theta = 0.75$, $\phi_\pi = 1.5$, and $\rho_z = \rho_u = 0.5$. Does Figure 2 show the responses from a discount rate or cost-push shock? Explain how one can distinguish between the two shocks. And explain how the shock feeds into the economy.

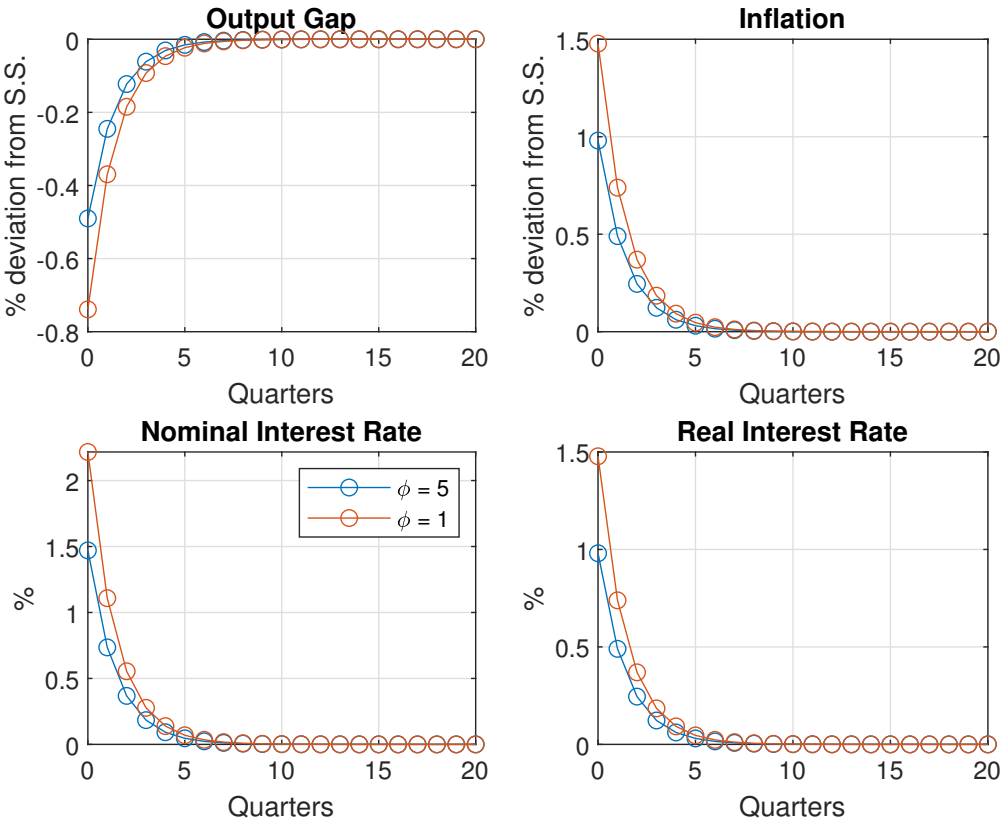


Figure 3: Impulse Responses

c) **Parameter changes.**

We now reduce ϕ from 5 to 1. All other parameters are the same as in problem b. Figure 3 presents the impulse responses in the benchmark scenario and in the new calibration. Explain what ϕ 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 3.

d) **Optimal monetary policy.**

We are now going to solve for optimal monetary policy under discretion. Assume that the central bank minimizes the following loss function

$$\mathcal{L} = \frac{1}{2}\mathbb{E}_t \sum_{k=0}^{\infty} \beta^k (\lambda y_{t+k}^2 + \pi_{t+k}^2) \tag{7}$$

where $\lambda > 0$. Minimize the loss function (7) subject to the Phillips curve (1) under discretion. What is the trade-off the central bank faces? How does the central bank optimally respond to a discount rate shock?