The exam consists of four parts: A, B, and C. In the grading, part A has 20% weight, part B has 40% weight, and part C has 40% weight. Allocate your time accordingly.

Part A: Monetary Policy Report 1/24 (20%)

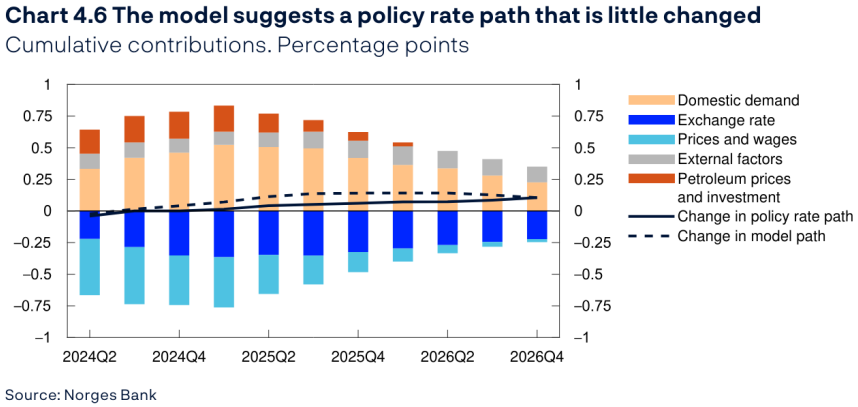


Figure 1: Accounting for changes in the interest rate forecast, MPR 1/24

Figure 1 displays the model-based accounting of changes in the interest rate path by Norges Bank at the interest rate meeting in March 2024. Discuss the contributors behind each of the five bars in the figure and why they contribute by raising or lowering the interest rate path.

Part B: Optimal Price Setting (40%)

In this problem, we are going to solve the firm problem with sticky prices. The firm problem is:

$$\max_{P_t^*,\{N_{t+k},Y_{t+k}\}_{k=0}^{\infty}} E_t \sum_{k=0}^{\infty} (\beta\theta)^k \left\{ \frac{U_{c,t+k}}{U_{c,t}} \frac{P_t}{P_{t+k}} \left(P_t^*(i) Y_{t+k|t}(i) - W_{t+k} N_{t+k|t}(i) \right) \right\} \tag{1}$$

subject to

$$Y_{t+k}(i) = N_{t+k}(i)^{1-\alpha} \tag{2}$$

$$Y_{t+k|t}(i) = \left(\frac{P_t^*(i)}{P_{t+k}} \right)^{-\epsilon} Y_{t+k} \tag{3}$$

where P_t^* is the optimal price in period t, $U_{c,t+k}$ is the marginal utility of consumption in period $t+k$, W is the aggregate nominal wage, N is hours, Y is aggregate output, P is the aggregate price, α is the curvature of the production function, and the notation $\cdot_{t+k|t}$ denotes the value of that variable in period $t+k$ for a firm that last reset its price in period t.

a) The current period version of equation (3) is

$$Y_t(i) = \left(\frac{P_t(i)}{P_t}\right)^{-\varepsilon} Y_t. \tag{4}$$

Interpret equation (4).

b) Log-linearize equation (4).

c) Assume that $\theta = 0$ (i.e., flexible prices). The Lagrangian for the firm problem is then

$$\mathcal{L}_t = P_t(i)Y_t(i) - W_t N_t(i) - \zeta_t(i)\left(Y_t(i) - \left(\frac{P_t(i)}{P_t}\right)^{-\varepsilon} Y_t\right) - \Psi_t(i)\left(Y_t(i) - N_t(i)^{1-\alpha}\right)$$

Find the first order conditions with respect to hours $N_t(i)$ and output $Y_t(i)$ and solve for $\Psi_t(i)$ and $\zeta_t(i)$, respectively. What is $\Psi_t(i)$? What is $\zeta_t(i)$?

d) What is the optimal price if $\theta = 0$ (flexible prices)?

e) The log-linearized optimal price setting equation for the problem with $\theta > 0$ is

$$p_t^* = \mu + (1 - \beta\theta)\sum_{k=0}^{\infty} (\beta\theta)^k E_t\{\psi_{t+k|t}\} \tag{5}$$

with $\mu = \log M$ and $\psi_{t+k|t} = \log \Psi_{t+k|t}$.

Use equation (5) to explain how prices are set when prices are sticky. Compare the solution with sticky prices (5) with the solution with flexible prices (problem d). How do the two solutions differ?

Part C: Monetary policy in the New Keyensian Model (40%)

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

$$\pi_t = E_t\{\pi_{t+1}\} + \kappa x_t \tag{6}$$
$$x_t = E_t\{x_{t+1}\} - (i_t - E_t\{\pi_{t+1}\}) + d_t \tag{7}$$
$$i_t = \phi_\pi \pi_t \tag{8}$$
$$d_t = \rho d_{t-1} + \eta_t \tag{9}$$
$$\eta_t \sim N(0, \sigma_d) \tag{10}$$
$$\kappa = \left(1 + \frac{\phi + \alpha}{1 - \alpha}\right)\left(\frac{1 - \theta}{\theta}\right)(1 - \theta)\left(\frac{1 - \alpha}{1 - \alpha + \alpha\varepsilon}\right) \tag{11}$$

where x is the output gap, π is inflation, i is the nominal interest rate, and d is a demand shock. κ, ϕ_π, ρ, σ_d, ϕ, α, θ, and ε are known parameters.

a) Insert (8) into (7) and guess that

$$\begin{aligned} x_t &= \psi_{xd} d_t \\ \pi_t &= \psi_{\pi d} d_t \\ E_t\{x_{t+1}\} &= \rho \psi_{xd} d_t \\ E_t\{\pi_{t+1}\} &= \rho \psi_{\pi d} d_t. \end{aligned}$$

Find the solutions for ψ_{xd} and $\psi_{\pi d}$.

b) Figure 2 shows the impulse responses of the output gap, inflation, the real interest rate, the nominal interest rate, and the demand shock to an initial shock to ϵ_0^d of -0.5. We have used the following calibration: $\phi = 5$, $\alpha = 0.25$, $\epsilon = 9$, $\theta = 0.75$, $\phi_\pi = 1.5$, and $\rho = 0.75$. Explain why the demand shock affects the economy the way it does in Figure 2.

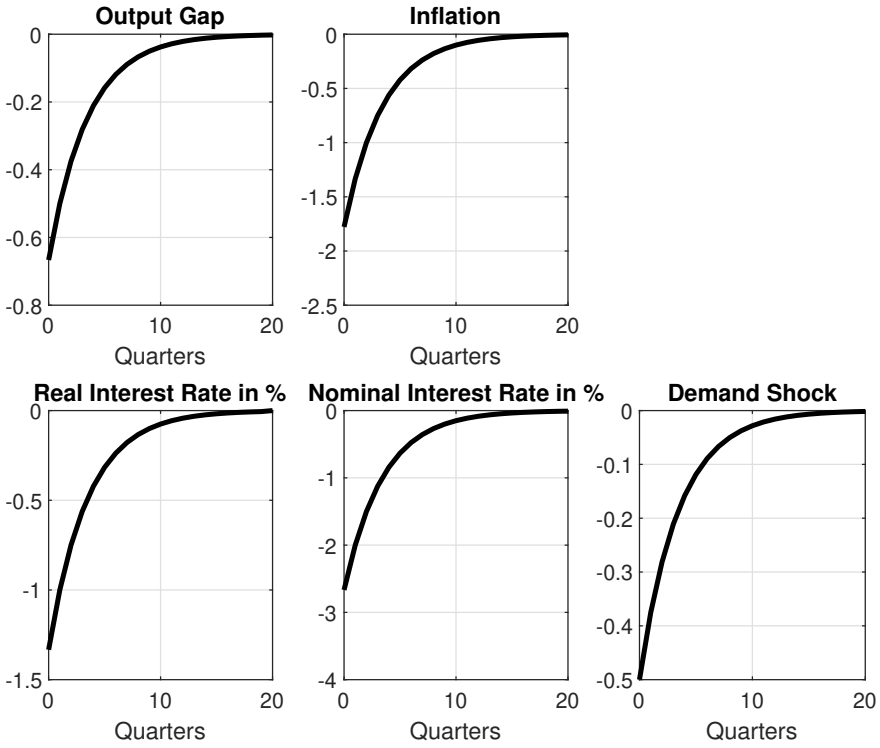


Figure 2: Impulse responses to a demand shock

c) We now change the calibration by lowering ε from 9 to 2. 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 ε is, how it changes the economic environment and how agents alter their behavior. Next, explain why the aggregate responses of the economy change in the way presented in Figure 3.

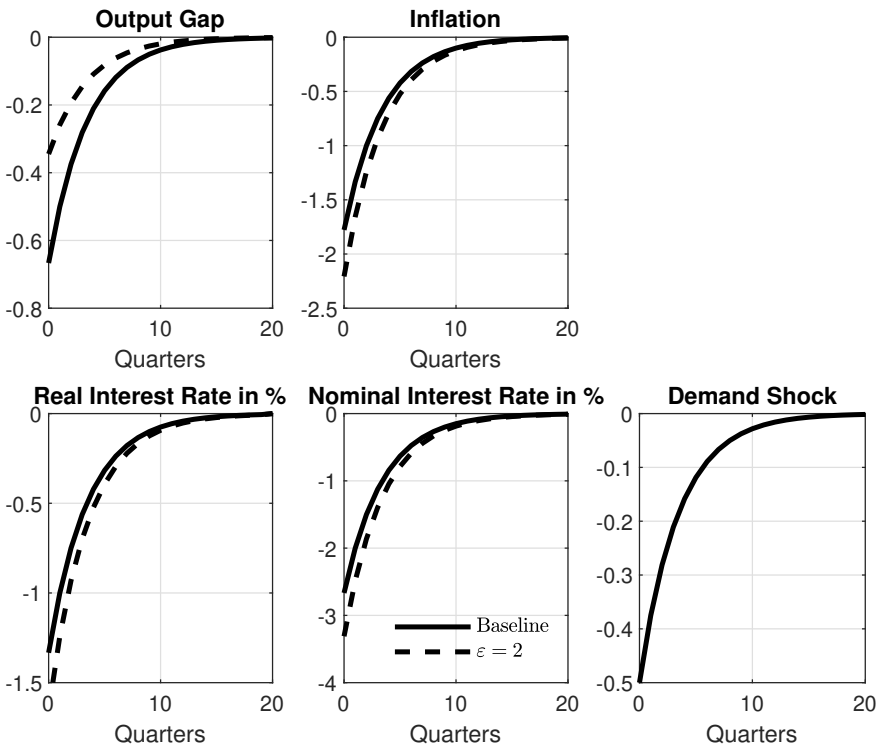


Figure 3: Impulse responses to a demand shock: variation in ε.

d) Assume now that the central bank follows optimal monetary policy instead of a Taylor rule (8) where the central bank cares about inflation and the output gap. The loss function is

$$\mathcal{L}_t = \frac{1}{2} \sum_{k=0}^{\infty} \left(\pi_{t+k}^2 + \lambda x_{t+k}^2 \right)$$

where $\lambda > 0$ is a parameter.

Show that the solution for optimal monetary policy under discretion is

$$\lambda x_t = -\kappa \pi_t. \tag{12}$$

and interpret equation (12).

e) Show that the optimal solution for the interest rate is

$$i_t = d_t$$

and explain the intuition for the implied interest rate rule.