ECON4325 spring -23 - Exam with solution proposal

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

Part A (50 %)

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

a) **Unconventional monetary policy.**

   i) Discuss why unconventional monetary policy was used after the global financial crisis.

   ii) How could quantitative easing (QE) and credit easing (CE) affect the price of credit and the supply of credit. Explain how QE and CE affect the balance sheet of central banks and private banks.

b) **Monetary policy and financial stability.**

   Section 3 in the "Regulation of Monetary policy" in Norway states: The operational target of monetary policy shall be annual consumer price inflation of close to 2 percent over time. Inflation targeting shall be forward-looking and flexible so that it can contribute to high and stable output and employment, and to counteracting the build-up of financial imbalances.

   i) What are the arguments for mandating monetary policy to counteract "the build-up of financial imbalances"?

   ii) What could be the implication for inflation and output gap by introducing a financial gap in a central bank's loss function? Relate the discussion to the current economic situation in Norway.

   iii) What is macroprudential policy and why was it introduced after the global financial crisis?

c) **Intratemporal Labor Choice.**

The intratemporal choice between consumption and labor is the solution to the following maximization problem

$$\max_{C_t, N_t} \frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\phi}}{1+\phi} \text{ subject to } P_t C_t = W_t N_t$$

i) Show that the first order conditions can be written as

$$N_t^{\phi} = \frac{W_t}{P_t} C_t^{-\sigma}. \tag{1}$$

ii) Interpret equation (1).

iii) Log-linearize equation (1).

iv) Show that $1/\phi$ is the Frisch elasticity in this model.

Part B (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 cost-push shock under an interest rate rule. We assume that the model is

$$\pi_t = \beta E_t\{\pi_{t+1}\} + \kappa y_t + u_t \tag{2}$$

$$y_t = E_t\{y_{t+1}\} - (i_t - E_t\{\pi_{t+1}\}) \tag{3}$$

$$i_t = \phi_\pi \mathbb{E}_t\{\pi_{t+1}\} \tag{4}$$

$$r_t = i_t - \mathbb{E}_t\{\pi_{t+1}\} \tag{5}$$

$$u_t = \rho_u u_{t-1} + \nu_t^u, \qquad \nu_t^u \sim N(0, \sigma_u) \tag{6}$$

$$\kappa = \left(1 + \frac{\phi + \alpha}{1 - \alpha}\right)\left(\frac{1-\theta}{\theta}\right)(1 - \beta\theta)\left(\frac{1-\alpha}{1 - \alpha + \alpha\varepsilon}\right) \tag{7}$$

where π is inflation, y is the output gap, i is the interest rate, r is the real interest rate, 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.**

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

$$y_t = \psi_y u_t, \quad E_t\{y_{t+1}\} = \rho_u \psi_y u_t,$$
$$\pi_t = \psi_\pi u_t, \quad E_t\{\pi_{t+1}\} = \rho_u \psi_\pi u_t,$$

and show that

$$\psi_y = -\rho_u(\phi_\pi - 1)\Lambda,$$
$$\psi_\pi = (1 - \rho_u)\Lambda,$$
$$\Lambda = \frac{1}{(1 - \beta\rho_u)(1 - \rho_u) + \kappa\rho_u(\phi_\pi - 1)}.$$

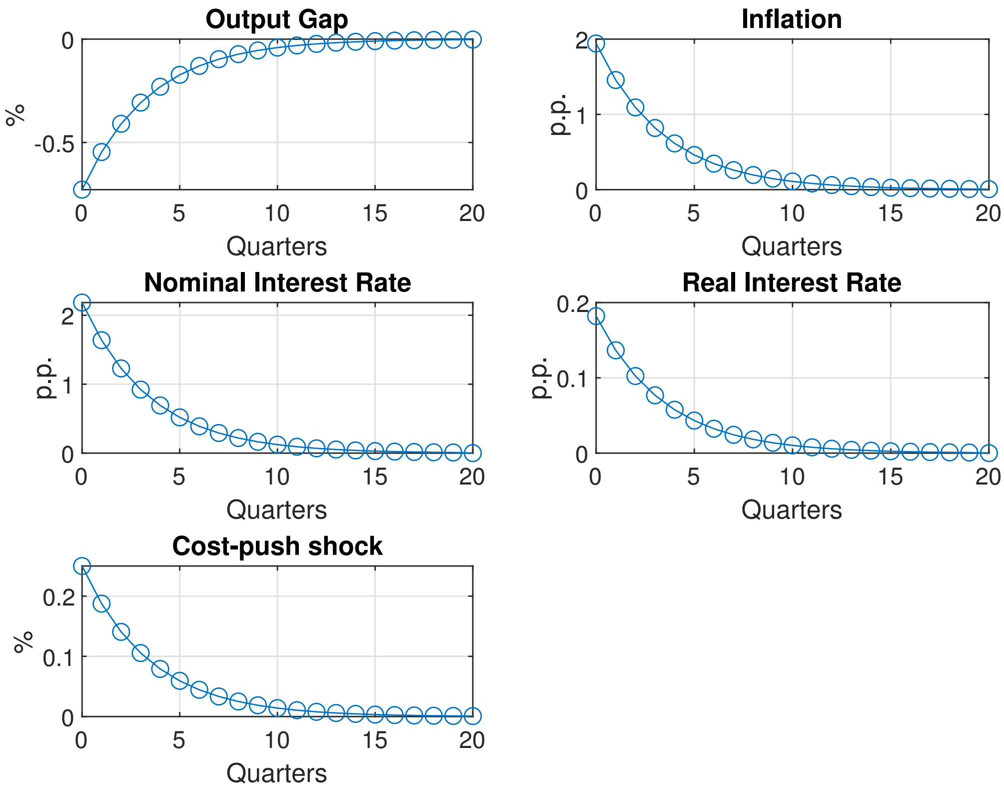

Figure 1: Impulse Responses to a Cost-Push Shock under a Taylor Rule.

b) **Interpretation of impulse responses.**

Figure 1 shows the impulse responses of the output gap, inflation, the nominal interest rate, the real interest rate, and the cost-push shock to a 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 $\rho_u = 0.75$. Explain how and why the shock affects the economy in the way displayed in Figure 1.

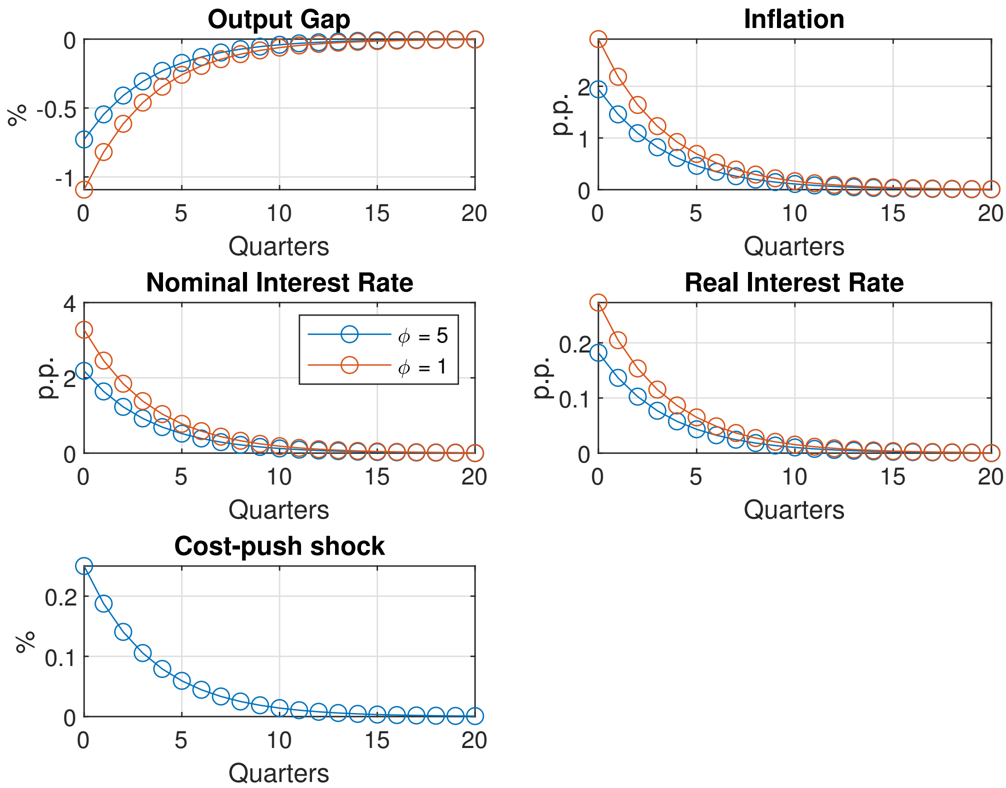

Figure 2: Impulse Responses to a Cost-Push Shock under a Taylor Rule.

c) **Parameter changes.**

We now reduce ϕ from 5 to 1. 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 ϕ is, how it changes the economic environment, and explain how agents alter their behavior. Next, explain why the impulse responses change in the way they do in Figure 2.

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

$$\mathcal{L} = \frac{1}{2}\mathbb{E}_t \sum_{k=0}^{\infty} \beta^k (\lambda y_{t+k}^2 + \pi_{t+k}^2) \tag{8}$$

where $\lambda \geq 0$ is the relative weight on output in the loss function. Minimize the loss function (8) subject to the Phillips curve (2) under discretion. What is the trade-off the central bank faces?

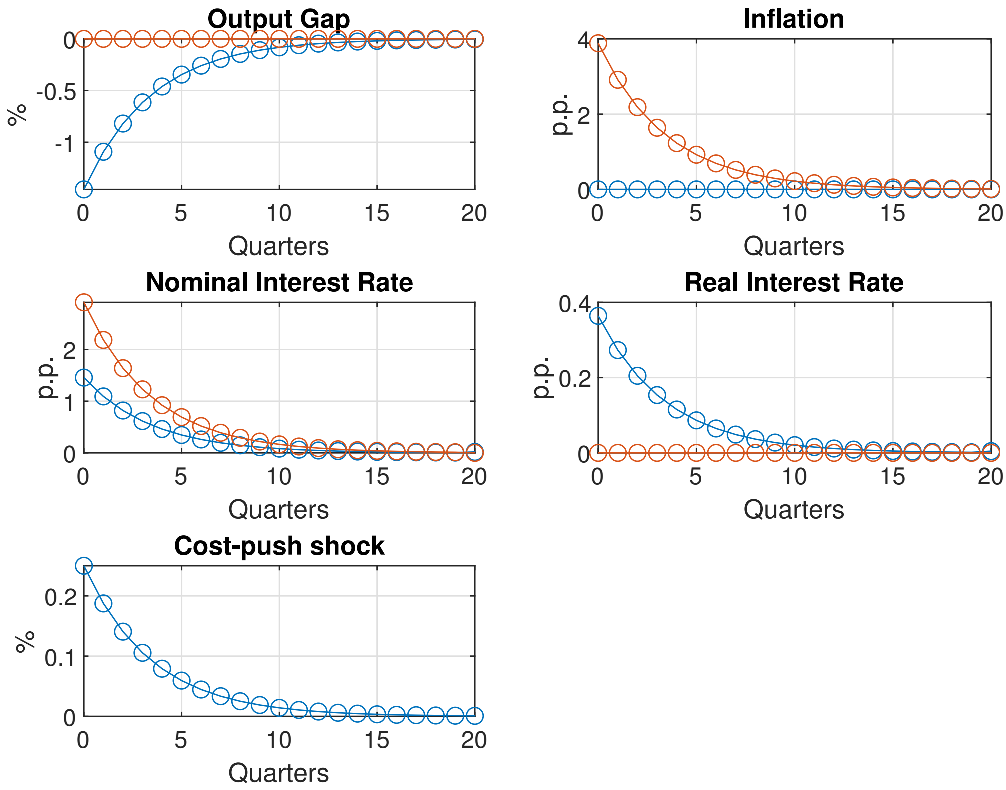

Figure 3: Impulse Responses to a Cost-Push Shock under Optimal Monetary Policy.

e) **Impulse responses under optimal monetary policy.**

Figure 3 displays the impulse responses in an economy with $\lambda = 0$ and $\lambda \to \infty$.[1] Explain in words which one (red or blue) is an economy with $\lambda = 0$ and which one is an economy with $\lambda = \infty$. Both policies ($\lambda = 0$ and $\lambda = \infty$) can be implemented in the setting with a Taylor rule above by adjusting ϕ_π in equation (4). What values of ϕ_π in a model with a Taylor rule correspond to the same policies as $\lambda = 0$ and $\lambda = \infty$, respectively, under optimal monetary policy?

Note: in this problem, the task is to fill in the table below and explain why that is the solution.

	color in Fig. 3	ϕ_π in Eqn. (4)
$\lambda = 0$		
$\lambda \to \infty$		

[1]Strictly speaking, I use λ equal to a very high finite number, not ∞.

Solution Proposal

Part A

a) **Unconventional monetary policy.**

   i) The students should mention that interest rates were reduced to zero but there was a need for further stimulus (liquidity trap).

   ii) The students should mention that as an overview, QE/CE can reduce the price of credit by reducing the interest rates on risk-free bonds and reducing risk premia. It works by reducing the liquidity risk faced by banks and by increasing banks' equity (if there are capital gains on banks assets due to QE/CE). It is important to discuss how banks' credit creation can be independent of central bank policies, but that the banks need to be willing to do it, thus policies that affect liquidity risk and equity may still increase credit supply. For the central bank, QE/CE raises their reserves on the liability side, while their increase the amount of securities on the asset side. For private banks, QE/CE swaps some of their securities for central bank reserves.

b) **Monetary policy and financial stability.**

   i) The arguments behind mandating the central bank to counteract the build-up of financial imbalances are that the costs of financial crises are enormous. Theoretically, the costs of financial crises could be captured by the projections of future inflation and output gaps, but this is very hard in practice (asset pricing, non-linearities, ...). Introducing the extra mandate ensures an additional focus on the build-up of financial imbalances. However, the financial supervision authorities typically have the primary responsibility for reducing the likelihood of financial crises and monetary policy only plays a secondary role here.

   ii) The trade-offs in monetary policy becomes more complicated when introducing a financial gap in the central bank's loss function. For example, a demand shock could now introduce a trade-off. In absence of the financial gap concern, the central bank will always cancel out demand shock. That is no longer true when we introduce a financial gap.

   In 2021 and 2022, the concern for financial stability was used as an additional argument for raising interest rates from very low levels. Today, the concern for financial stability typically pushes central banks in the direction of more caution when raising interest rates because they are concerned about starting a financial crisis (housing market collapse/bank sector troubles). A consequence is that it will take longer to get inflation back to the inflation target.

iii) The starting point of macroprudential policies is that there are mechanisms in which bank behavior is procyclical and may amplify business cycle fluctuations (financial accelerator mechanisms). Macroprudential regulation was introduced after the global financial crisis to reduce this behavior. The students should mention an example of a financial accelerator mechanism (for example how an increase in equity in expansions affect banks' lending capacity) and how a specific policy addresses this (the countercyclical capital buffer).

c) **Intratemporal labor choice.**

i) Direct computation.

ii) The left-hand side of equation (1) is the marginal cost from working one more hour, the right-hand side is the marginal benefit from working one more hour in terms of extra consumption.

iii) Log-linearized solution:

$$\phi n_t = w_t - p_t - \sigma c_t$$

where lower-case letters are log-deviations.

iv) The Frisch elasticity is the elasticity of labor supply with respect to real wage changes. To show that $1/\phi$ is the Frisch elasticity, just rearrange the equation such that

$$n_t = \frac{1}{\phi}(w_t - p_t) - \frac{\sigma}{\phi} c_t.$$

Part B

a) Solve by method of undetermined coefficients.

b) Initially, the cost push shock raises prices. The central bank responds to this (expected) price rise by increasing the interest rate more than one-for-one. Hence, the real interest rate increases and output contracts. As output contracts, the initial impact on inflation is somewhat dampened. The total effect is that inflation goes up, output declines, the nominal interest rate goes up, and the real interest rate goes up.

c) ϕ is the inverse of the Frisch elasticity. When ϕ declines, households become more responsive to wage changes: a given reduction in output affects wages and thus prices less, resulting in a lower κ and a flatter Phillips curve. In Figure 2, this implies that when the central bank responds to the initial increase in (expected) inflation by raising the nominal and real interest rate, it affects output to the same extent, but the output decline has less effect on inflation. Hence, the dampening effect of monetary policy is weaker and the central bank has to respond even stronger. The total effect is thus that inflation is higher, output is lower, the nominal interest rate is higher, and the real interest rate is higher.

d) The solution under discretion is $\lambda y_t = -\kappa\pi_t$. When the economy faces cost-push shocks, the central bank has to engineer a recession to reduce inflation. The optimal policy is to set equate the marginal benefit from engineering a recession ($-\kappa\pi_t$) equal to the marginal costs of the recession (λy_t).

e) The red line has no output response and thus need to have the solution that $\lambda = \infty$. Conversely, the blue line has no inflation response and thus need to have the solution $\lambda = 0$. One can see this directly from the solution in problem d, or use a verbal argument. To get those two solution under a Taylor rule, the solution is to set $\phi_\pi = 1$ to get the $\lambda = \infty$ solution. The reason is that with $\phi_\pi = 1$, the real interest rate never moves such that the central bank ensures that the output gap is always zero. To get the solution with $\lambda = 0$ (care only about inflation), the central bank has to set $\phi_\pi = \infty$. In that case, the central bank cares only about inflation and ensures that the inflation gap is always closed, as in the blue solution.