The exam consists of four parts: A, B, C, and D. In the grading, part A has 10% weight, part B has 30% weight, part C has 30% weight, and part D has 30% weight. Allocate your time accordingly.

Part A: Short question (10%)

What is the purpose of macroprudential policy? Provide two examples of macroprudential policies and explain why each is a macroprudential policy.

Part B: The household problem (30%)

In this problem, we will solve the household problem:

$$\max_{\{C_{t+k},N_{t+k},B_{t+k+1}\}_{k=0}^{\infty}} \mathbb{E}_t \sum_{k=0}^{\infty} \beta^k U(C_{t+k}, N_{t+k}) \tag{1}$$

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 dividends from firms, $\beta \in [0, 1)$ is the discount rate, and U is the utility function.

a) Assume that $U(C, N) = \frac{C^{1-\sigma}-1}{1-\sigma} - \frac{N^{1+\phi}}{1+\phi}$ and show that the first order conditions are

$$C_{t+k}^{-\sigma} \frac{W_{t+k}}{P_{t+k}} = N_{t+k}^{\phi} \;\forall\; k \geq 0 \tag{4}$$

$$C_{t+k}^{-\sigma} = \beta(1+i_{t+k}) \mathbb{E}_{t+k} \left\{ C_{t+k+1}^{-\sigma} \frac{P_{t+k}}{P_{t+k+1}} \right\} \tag{5}$$

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

c) Assume now that $U(C, N) = \frac{1}{1-\sigma}\left(C - \frac{N^{1+\phi}}{1+\phi}\right)^{1-\sigma}$ and compute the intratemporal first-order condition (labor supply equation). How is the condition different from the intratemporal first-order condition above (4)?

Part C: A monetary policy shock (30%)

Note: this problem has two pages.
Consider the New Keynesian model with a monetary policy shock:

$$\pi_t = \beta E_t\{\pi_{t+1}\} + \kappa \tilde{y}_t \tag{6}$$
$$\tilde{y}_t = E_t\{\tilde{y}_{t+1}\} - (i_t - E_t\{\pi_{t+1}\}) \tag{7}$$
$$i_t = \phi_\pi \pi_t + \phi_y \tilde{y}_t + v_t \tag{8}$$
$$v_t = \rho v_{t-1} + u_t^v \tag{9}$$
$$u_t^v \sim N(0, \sigma_v) \tag{10}$$
$$\kappa = \left(1 + \frac{\phi}{1-\alpha} + \frac{\alpha}{1-\alpha}\right)\left(\frac{1-\theta}{\theta}\right)(1-\beta\theta)\left(\frac{1}{1+\frac{\alpha\varepsilon}{1-\alpha}}\right) \tag{11}$$

where π is inflation, $\tilde{y}$ is the output gap, i is the nominal interest rate, and v is a monetary policy shock. The parameters β, κ, α, ϕ, ε, θ, ϕ_π, ϕ_y, ρ, and σ_v are strictly positive.

a) Show that the responses of inflation and the output gap to the monetary policy shock are

$$\tilde{y}_t = -\frac{(1-\beta\rho)}{(1-\beta\rho)(1-\rho+\phi_y) + \kappa(\phi_\pi - \rho)} v_t,$$
$$\pi_t = -\frac{\kappa}{(1-\beta\rho)(1-\rho+\phi_y) + \kappa(\phi_\pi - \rho)} v_t.$$

b) Figure 1 shows the impulse responses of the output gap, inflation, the nominal interest rate, and the real interest rate to an initial shock to u_0^v of 0.5. We have used the following calibration: $\beta = 0.99$, $\phi = 5$, $\alpha = 0.25$, $\varepsilon = 9$, $\theta = 0.75$, $\phi_\pi = 1.5$, $\phi_y = 0$, and $\rho_v = 0.5$. Explain why the monetary policy shock affects the economy like it does in Figure 1.

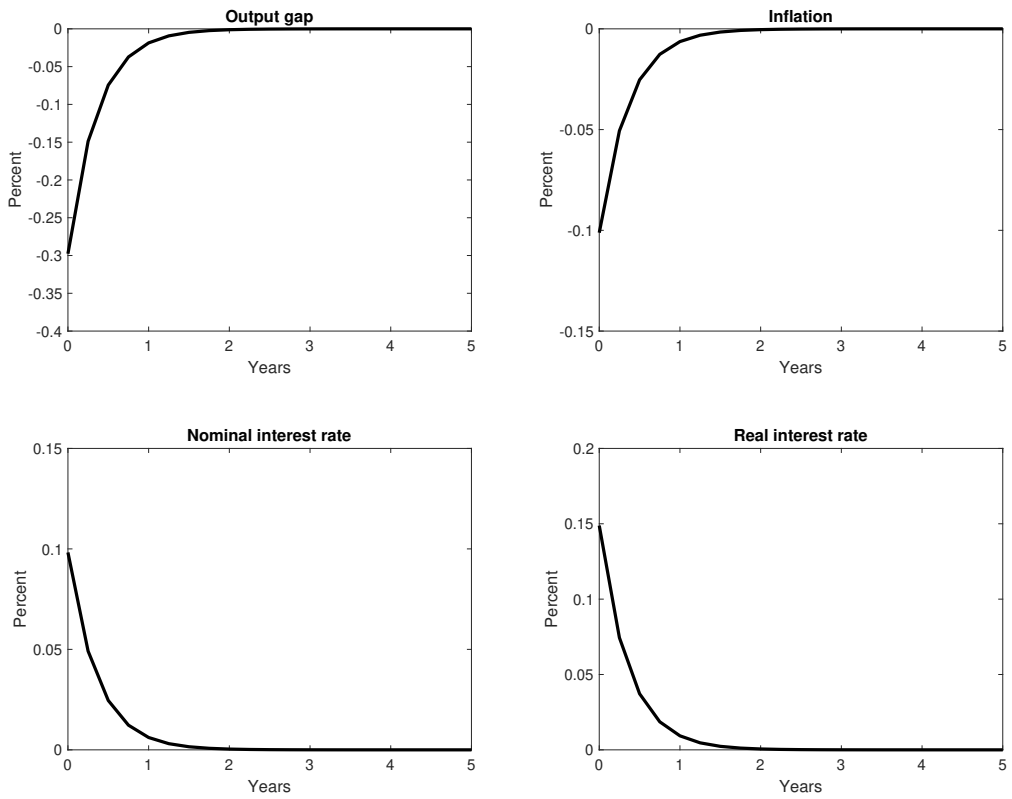


Figure 1: Impulse responses to a monetary policy shock.

c) We now change the calibration by reducing θ from 0.75 to 0.50. All other parameters are the same as in problem Cb. How does such a change in θ affect how the output gap, the inflation rate, the nominal interest rate, and the real interest rate respond to monetary policy?

d) Suppose now that we increase ϕ_π from 1.5 to a very large number. How does the output gap and inflation response to the monetary policy shock change as the central bank becomes more aggressive against inflation (a higher ϕ_π)? Explain the intuition.

Part D: Monetary policy in an open economy (30%)

Assume a small open economy model with an exogenous global interest rate r^*. Macroeconomic policy sets the interest rate (r, monetary policy) and determines the size of public expenditure (g, fiscal policy). The optimal response of monetary and fiscal policy to shocks (u, z, v) is:

$$r = \frac{1}{\gamma_2}\left[(\pi^e - \pi) + u\right] + (e^e + r^* + z) \tag{12}$$

$$g = -\frac{1}{\alpha_3}v + \frac{\alpha_1 + \alpha_2}{\alpha_3\gamma_2}\left[(\pi^e - \pi) + u\right] + \frac{\alpha_1}{\alpha_3}(e^e + r^* + z) \tag{13}$$

where π^e is inflation expectation, π^* 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 (γ_2, α_1, α_2, and α_3) are strictly positive.

a) Discuss the characteristics of a Central Bank's loss function in this model.

b) How is the exchange rate determined in the model?

c) Discuss how monetary and fiscal policy should respond to

i. A negative demand shock v?

ii. A negative inflation shock u?

d) What does the analysis tell us about the interaction between monetary and fiscal policy?

e) Explain the Tinbergen Rule.

Solution Proposal

Part A: The firm problem (10%)

The purpose of macroprudential policy is to counteract the pro-cyclical behavior of banks. The candidate should give two examples of such policies, describe the rationales behind the policies, and explain how they work.

Part B: The household problem (30%)

a) *Since the student is given the solution, it is important that the computation steps are correct. In particular, the first-order condition with respect to bonds tends to be wrong.*

b) *Equation* (4)*: intratemporal consumption-leisure choice. Trade-off: consumption or leisure. The marginal utility of working one more hour and consuming the income equals the marginal disutility from working one more hour.*

Equation (5)*: intertemporal consumption choice. Trade-off: consume today or tomorrow. The marginal utility of one more unit of consumption today should equal the discounted marginal utility of saving today, earn interest, and consume tomorrow.*

c) *The solution is:*

$$\frac{W_t}{P_t} = N_t^{\phi}$$

Compared with (4)*, the marginal utility of consumption does not enter. There is no wealth effect on labor supply for these preferences; only the real wage matters.*

Part C: A monetary policy shock (30%)

a) *Solve by the method of undetermined coefficients.*

b) *With a positive monetary policy shock (a higher interest rate), the real interest rate increases, inducing households to cut consumption today. The reduction in consumption, and thus the output gap, also leads to lower inflation via the Phillips curve. The central bank responds to lower inflation by reducing the interest rate, dampening some of the initial impact of the monetary policy shock.*

c) *The student first has to explain what θ is and how it affects the slope of the Phillips curve. θ governs price stickiness. A higher θ means prices are more sticky (fewer firms can adjust prices). When fewer firms adjust, prices move more in response to a change in the output gap (a higher κ).*

A higher κ implies that the initial increase in the real interest rate that reduced output led to a greater fall in inflation. The central bank, following a Taylor rule with only a weight on inflation, reacts to this stronger inflation response by cutting the interest rate more. The total response is thus that the interest rate increases less, the real interest rate increases less, the output gap falls less, and inflation falls more - as seen in Figure 2.

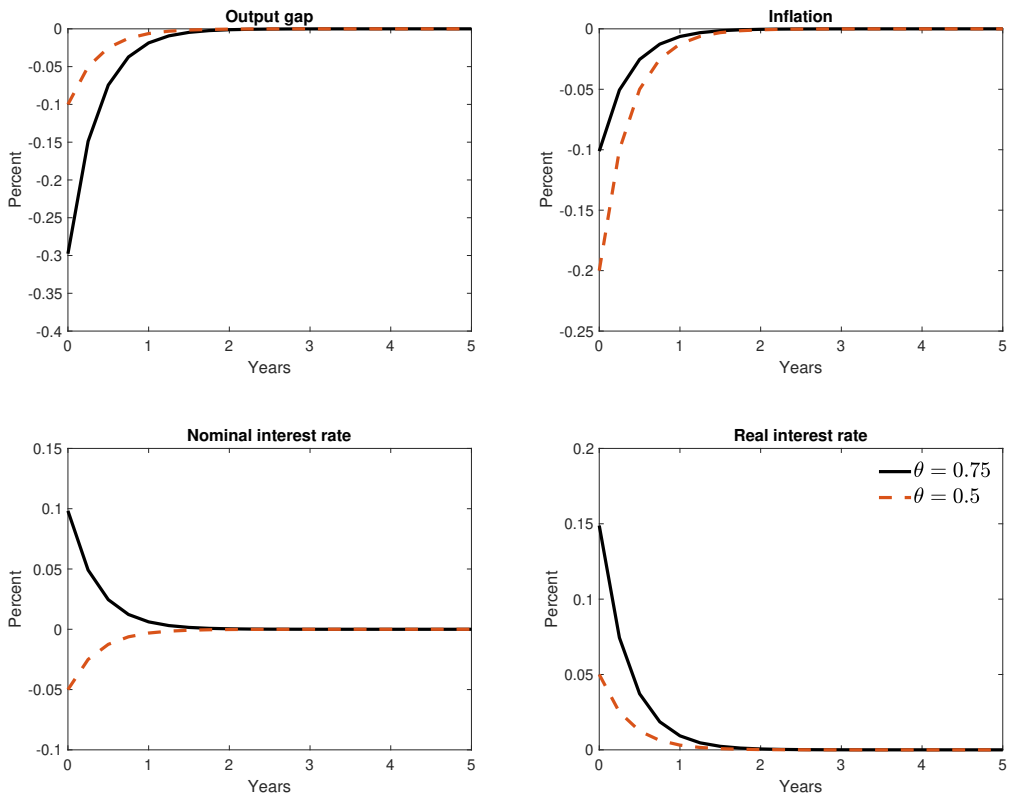


Figure 2: Impulse responses to a monetary policy shock.

d) *When the central bank becomes more aggressive toward inflation $\phi_\pi \uparrow$, both the output gap and inflation respond less to the initial monetary policy shock. When $\phi_\pi \to \infty$, neither the output gap nor inflation responds because the central bank fully cancels out the initial shock.*

Part D: Monetary policy in an open economy (30%)

a) *The loss function is given by:*

$$L = \frac{1}{2}[(\pi - \pi^*)^2 + \lambda y^2].$$

The candidate should discuss the implications of the quadratic form (positive vs negative gap, small vs large gap).

b) *Uncovered interest rat parity. The candidate should be able to distinguish between the effects of a surprise change in the interest rate vs the effects over time that entails that the exchange rate should offset the interest rate differential so that the expected return will be equal (adjusted for a risk premium).*

c) *If the central bank lowers interest rates in response to a negative demand shock to prevent a reduction in y, inflation will become too high because the exchange rate weakens due to lower interest rates. Therefore, in an open economy, monetary policy cannot simultaneously shield both the real economy and inflation from the effects of a demand shock. On the other hand, expansionary fiscal policy can shield both the real economy and inflation from the effects of a demand shock because it does not directly affect the exchange rate. The mechanism is as simple as replacing lower private demand (negative shock) with higher government demand.*

With an optimal combination of expansionary monetary policy and contractionary fiscal policy, the decrease in inflation can be completely offset by a weaker exchange rate without the need for the output gap to become positive. The divergent policy composition allows the exchange rate channel to be more effectively utilized, enabling the simultaneous achievement of price stability and stability in the real economy.

d) *We can see from the equations that monetary and fiscal policy should respond divergently to all shocks except demand shocks (where only fiscal policy should respond). Therefore, the policy instruments should generally pull in opposite directions. Fiscal policy should be expansionary (high g) when monetary policy is contractionary (high r), and vice versa. It follows from this that monetary policy has a stronger impact on inflation relative to output compared with fiscal policy. The comparative advantage of monetary policy lies in its ability to influence inflation, while the comparative advantage of fiscal policy lies in its ability to influence output*

e) *With two instruments, two objectives can be reached (both inflation equal to the target and output gap equal to zero).*