The exam consists of three parts, A, B, and C, with equal weight (1/3). Remember to allocate your time accordingly.

Part A (1/3 of the exam): Essay

Write a short essay addressing the following question in 500–750 words. In addressing the question, relate to the course literature.

What are Friedman (1953)'s and Lucas (1976)'s criteria for a "good" model? In your opinion, which (or both, or neither) of these criteria do medium-sized DSGE models such as Norges Bank's model NEMO, as described in Gerdrup and Nicolaysen (2011), strive to satisfy? How about the SAM framework ("System for Averaging Models")?

References

Friedman, M. (1953). The methodology of positive economics.

Gerdrup, K. R. and Nicolaisen, J. (2011). On the purpose of models - The Norges Bank experience. *Norges Bank Staff Memo*, (6).

Lucas, R. E. (1976). Econometric policy evaluation: A critique. *Carnegie-Rochester Conference Series on Public Policy*, 1:19–46

Part B (1/3 of the exam): Consumption-Saving Models

Consider the following two-period household model

$$\max_{c_1,b_1,c_2} \frac{c_1^{1-\sigma}}{1-\sigma} + \frac{c_2^{1-\sigma}}{1-\sigma}$$
$$\text{subject to}$$
$$c_1 + b_1 = y$$
$$c_2 = (1+r)b_1$$

where c is consumption, y is income, b is savings, $\sigma > 0$ is a parameter, and r is the interest rate.

1. Show that the Euler equation is $c_1^{-\sigma} = (1+r)c_2^{-\sigma}$.
2. Explain why consumption growth depends on the interest rate r.
3. Show that consumption in period 1 is $c_1 = \frac{y}{1+(1+r)^{1/\sigma-1}}$.
4. Explain intuitively why the effect of a change in the interest rate r on c_1 is ambiguous and depends on $(1/\sigma - 1)$. Why is the effect negative if $1/\sigma > 1$?

Consider a modified version of the model

$$\max_{\{c_1,b_1,c_2\}} \frac{c_1^{1-\sigma}}{1-\sigma} + \frac{c_2^{1-\gamma}}{1-\gamma}$$
$$\text{subject to}$$
$$c_1 + b_1 = y$$
$$c_2 = b_1$$

where c is consumption, y is income, b is savings, and $\sigma > 0$ and $\gamma > 0$ are parameters. Note that there are two differences compared with the problem above: (i) consumption in period 2 has a different curvature parameter and (ii) there is no interest rate ($r = 0$).

5. Show that $c_2 > c_1$ if $\sigma > \gamma$ and explain why the growth of consumption (c_2 relative to c_1) now depends on σ relative to γ.

Part C (1/3 of the exam): The Solow Model

In this exercise, we consider the Solow model. There is no technological growth and no population growth. Output Y_t is given by $Y_t = F(K_t, L)$ where F is an aggregate production function satisfying the usual ("neoclassical") properties, where K_t is capital at time t and L is the (constant) labor force. Capital depreciates at rate $\delta > 0$, so we have $K_{t+1} = I_t + (1-\delta)K_t$. Investment is a constant share of output, $I_t = sY_t$. The economy is closed (no trade with other economies) so $Y_t = C_t + I_t$

1. Given these assumptions, show that the law of motion for capital is given by $K_{t+1} = sF(K_t, L) + (1-\delta)K_t$.

2. In the long run, the capital stock converges to its steady state value K_{ss}. Show that the steady-state capital-output ratio is $K_{ss}/Y_{ss} = s/\delta$.

3. Now, we consider the special case with $F(K_t, L) = K_t^\alpha L^{1-\alpha}$. For simplicity, assume $L = 1$, so $F(K_t, L) = K_t^\alpha$ with $\alpha > 0$. Show that steady-state capital is given by $K_{ss} = (s/\delta)^{1/(1-\alpha)}$ and steady-state output is given by $Y_{ss} = (s/\delta)^{\alpha/(1-\alpha)}$.

4. If the saving rate s increases, does steady-state output Y_{ss} necessarily increase? Provide a mathematical argument for your conclusion.

5. Steady-state consumption is given by $(1-s)Y_{ss}$. If the saving rate s increases, does steady-state consumption C_{ss} necessarily decrease? Provide an argument for your conclusion (which need not be mathematical).