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): Labor Supply Models

Consider the following household model

$$\max_{c,n} \frac{c^{1-\sigma}}{1-\sigma} - \frac{n^{1+\phi}}{1+\phi} \quad \text{subject to} \quad c = wn \tag{1}$$

where c is consumption, n is hours worked, $\sigma > 0$ and $\phi > 0$ are parameters, and w is the real wage.

1. Show that the first-order conditions can be combined to give

$$c^{\sigma} n^{\phi} = w. \tag{2}$$

2. Interpret the optimality condition (2). Explain in words what the income and substitution effects of wage changes on labor supply are.

3. Combine equation (2) and the budget constraint to solve for consumption as a function of the real wage only. What happens to consumption if the real wage increase? Explain intuitively the channels that operate.

Consider now the following alternative model

$$\max_{c,n} \frac{\left(c - \frac{n^{1+\phi}}{1+\phi}\right)^{1-\sigma}}{1-\sigma} \quad \text{subject to} \quad c = wn. \tag{3}$$

4. Show that the first-order conditions can be combined to give

$$n^{\phi} = w. \tag{4}$$

5. Interpret the optimality condition (4). Explain intuitively what is the difference in implied behavior between this alternative model (3) and the original model (1).

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

In this exercise, we consider the Ramsey model without population growth and without technological growth. The model is summarized by two equilibrium equations,

$$u'(c_t) = \beta(1 + f'(k_{t+1}) - \delta)u'(c_{t+1}),$$
$$k_{t+1} = f(k_t) + (1 - \delta)k_t - c_t,$$

where c_t denotes consumption at time t and k_t is capital at time t. The utility function u and the production function f satisfies the usual neoclassical properties.

1. What is the marginal product of capital in this environment?
2. What is the interest rate in this environment?
3. In the long run, the model converges to a "steady state": a situation where $c_t = c_{t+1} = \ldots = c_{ss}$ and $k_t = k_{t+1} = \ldots = k_{ss}$. What is the marginal product of capital and the interest rate in this steady state?
4. Assume $f(k) = k^\alpha$ and $\delta = 1$. What is the steady-state level of capital?
5. What is the steady-state level of consumption?

Solution Proposal

Part A

Here are criteria for answering part A well.

1. The student should demonstrate an understanding of the main criteria of a "good" model in (positive) economics in Friedman (1953).
2. The student should demonstrate an understanding what the Lucas critique is and what Lucas' criteria of a "good" model is (Lucas, 1976).
3. The student should demonstrate an understanding of Gerdrup and Nicolaysen (2011).
   (a) The student should provide a brief explanation of what a medium-sized DSGE model is (e.g., NEMO) and explain how it satisfies/does not satisfy the criteria in Friedman (1953) and Lucas (1976).
   (b) The student should provide a brief explanation of what SAM is and explain how it satisfies/does not satisfy the criteria in Friedman (1953) and Lucas (1976).
4. The essay should be well-structured and well-written.

If all four criteria are satisfied, the student should get a full score.

Part B

1. Solve using Lagrangian (or any other method).
2. If the wage increases, it has two effects: 1) it raises the price of leisure relative to consumption, inducing the worker to supply more hours (the substitution effect); 2) it makes the worker richer because for the same number of hours supplied as before, it can buy more goods, thus inducing the worker to supply less hours (the income effect).
3. Combining the budget constraint and the first-order condition, one gets $c = w^{\frac{1+\phi}{\sigma+\phi}}$. Consumption unambiguously increases if the real wage increases. This is because the both the income and substitution effect works in the same direction.
4. Solve using Lagrangian (or any other method).

5. In this alternative model, there is no income effect. Labor supply therefore unambiguously increases if real wages increases (the substitution effect).

Part C

1. The marginal product of capital is $f'(k)$.

2. The interest rate is $f'(k) - \delta$.

3. In steady state, the Euler equation reduces to

$$1 = \beta(1 + f'(k_{ss}) - \delta)$$

   or $f'(k_{ss}) = \beta^{-1} - 1 + \delta$. The interest rate is thus $\beta^{-1} - 1$.

4. Under the stated assumptions, $f'(k_{ss}) = \beta^{-1} - 1 + \delta$ reduces to $\alpha k_{ss}^{\alpha-1} = \beta^{-1}$ or $k_{ss} = (\alpha\beta)^{1/(1-\alpha)}$.

5. We plug in the value of k_{ss} into the law of motion for capital:

$$(\alpha\beta)^{1/(1-\alpha)} = (\alpha\beta)^{\alpha/(1-\alpha)} - c_{ss}$$

   or

$$c_{ss} = (\alpha\beta)^{\alpha/(1-\alpha)}(1 - \alpha\beta).$$