

# **UNIVERSITY OF OSLO**

## **DEPARTMENT OF ECONOMICS**

Exam: **ECON4325 – Monetary Policy**

Date of exam: Wednesday, May 13, 2015   **Grades are given:** June 3, 2015

Time for exam: 09.00 a.m. – 12.00 noon

The problem set covers 5 pages

Resources allowed:

- No resources allowed (except if you have been granted use of a dictionary from the Faculty of Social Sciences)

The grades given: A-F, with A as the best and E as the weakest passing grade. F is fail.

**The exam consists of three parts, 1, 2 and 3. In the grading, problem 1 is given 30 per cent weight, problem 2 is given 20 per cent weight, and problem 3 is given 50 per cent weight. The max page limit should be respected, but is not required (i.e. a shorter answer may be just as good).**

### **Problem 1a**

Imagine that you are working as a senior advisor in Norges Bank in May 2015, and that the next monetary policy meeting is one week away. The interest rate is now 1,25 percent after a 25 basis points interest rate cut at the last meeting.

The economic development since the last meeting can be described as follows:

- **The oil price** has fallen more than expected and is expected to stay at low levels for a long time.
- **The Norwegian Krone** has depreciated much more than expected. An appreciation is not expected any time soon.
- **Nominal wage growth** for both 2015 and 2016 is expected to be 2 percent, which is lower than expected.
- **CPI inflation** is on target, but future development is uncertain due to both upside and downside factors.
- **Real GDP growth** is positive, but lower than expected, and expected to stay lower than the potential growth rate for a while ahead.
- **Housing prices**, as well as household debt levels, have risen much more than expected, and are expected to rise further.
- **Foreign interest rates** have dropped more than expected. The expected rise in foreign rates has been postponed to late 2016, at the earliest.

In the following, it is taken for granted that you are familiar with Norges Bank's forward guidance strategy and three criteria for an appropriate interest rate path, to the extent that we have covered it in this course.

Based on the information given above, you are asked to write a recommendation on what to do with the interest rate at the next meeting. Your draft should make use of what you have learned in this course in general and the information given above in particular.

The Governor asks for your personal opinion and your draft should therefore give an independent and intuitive explanation for your choice of interest rate decision. In your answer, you should also sketch three interest paths: (i) your chosen one, (ii) how the path would have looked like if only criterion 1 was considered, and (iii) how the path would have looked like if only criteria 1 and 2 were considered. Briefly explain the difference between the paths. The paths should cover the time period from the day of the meeting and two years ahead.

Your written answer should exceed one page, but be no more than four pages long.

### **Problem 1b**

In this course (at lecture 2), you are presented with 5 different forms of central bank transparency. Name the 5 forms and provide one example of each. In particular, explain under which form one finds *minutes* from monetary policy meetings and the Norges Bank *interest rate path*, respectively. Furthermore, give a brief recommendation on whether Norges Bank should start publishing minutes. Your answer should include both arguments in favor of and against, as well as a clear recommendation, and should be no more than two pages long.

### **Problem 1c**

Briefly explain the difference between *Delphic* and *Odyssean* forward guidance, and between *time-contingent* and *state-contingent* Odyssean forward guidance, and give one example of each. Your examples should be picked from the guidance (present or past) provided by any of the four central banks which we follow in this course (i.e. Norges Bank, Fed, ECB and the Bank of England). Your answer should be no more than two pages long.

### **Problem 1d**

Explain with words and a figure the use and meaning of *Calvo-pricing* in this course. Your answer should be no more than one page long.

### **Problem 2**

In the New Keynesian Model used in this course, inflation is a result of aggregate consequences of carefully reasoned price-setting decisions made by firms based on their current and future cost conditions.

### Problem 2a

Price rigidity is a key element in the New Keynesian model. With Calvo pricing, it can be shown that gross inflation in this economy equals:

$$\Pi_t^{1-\varepsilon} = \theta + (1 - \theta) \left[ \frac{P_t^*}{P_{t-1}} \right]^{1-\varepsilon}, \quad \varepsilon > 1, 0 < \theta < 1 \quad (1)$$

where  $(1 - \theta)$  measures the fraction of firms that can reset their prices in any given period, while a fraction  $\theta$  keep their prices unchanged.  $\varepsilon$  is the demand elasticity,  $P_t^*$  is the optimal price chosen by the firms who can reset prices in period  $t$  and  $P_{t-1}$  is the aggregate price level in period  $t-1$ .

For a steady state gross inflation rate equal to 1, log-linearize equation (1) around its steady state. Interpret the solution.

### Problem 2b

It can further be shown that inflation evolves in the following way:

$$\pi_t = \beta E_t \{ \pi_{t+1} \} + \frac{(1-\theta)(1-\beta\theta)}{\theta} \Theta \widehat{mc}_t \quad (1)$$

where  $\pi_t$  is the log inflation rate in period  $t$ ,  $\widehat{mc}_t$  is the log deviation of aggregate marginal costs from the steady state value  $mc$ ,  $(1 - \theta)$  measures the fraction of firms that can reset their prices in any given period, while a fraction  $\theta$  keep their prices unchanged.  $\beta$  is the discount factor and

$\Theta = \frac{(1-\alpha)}{1-\alpha+\alpha\varepsilon}$ , where  $\alpha$  is a measure of decreasing return to scale and  $\varepsilon$  is the demand elasticity. It can further be shown that  $\widehat{mc}_t = \left( \sigma + \frac{\varphi+\alpha}{1-\alpha} \right) \tilde{y}_t$ , where  $\tilde{y}_t$  is the output gap,  $\sigma$  is the inverse of the intertemporal elasticity of substitution and  $\varphi$  is the inverse of the Frisch elasticity. It can also be shown that the optimal labor supply schedule for the household equals:  $\omega_t = \sigma c_t + \varphi n_t$ .

Describe in words the evolution of the inflation rate in period  $t$  when there is a positive shock to the output gap. (Hint: The more parameters interpreted, the higher is the score).

### Problem 3

Consider the following period utility function:

$$U(C_t, N_t) = \frac{1}{1-\sigma} [C_t(1 - N_t)^v]^{1-\sigma} \quad (2)$$

where  $C_t$  and  $N_t$  is private consumption and hours worked in period  $t$ , respectively, and  $v$  and  $\sigma$  is the Frisch elasticity and the inverse of the intertemporal elasticity of substitution, respectively. The economy, which is equivalent to the classical model economy described in

this course, consists of one representative household who lives forever and who chooses how much labor to supply and how to allocate income between consumption and one period bonds in every period. The household also faces a lump sum transfer,  $T_t$ , which can be both positive and negative. The household seeks to maximize discounted expected utility in every period.

- Show and explain the flow budget constraint for the household. Why is it called the *flow* budget constraint? Are there any other constraints worth mentioning, given the description of this economy?
- Show that the household's marginal utility of consumption and marginal disutility of labor equal  $\frac{(1-N_t)^{v(1-\sigma)}}{C_t^\sigma}$  and  $\frac{-v[C_t(1-N_t)^v]^{1-\sigma}}{(1-N_t)}$ , respectively. Interpret the two solutions. In particular, explain why the solutions depend on the size of  $\sigma$ .
- Show that the two household optimality conditions equal:

$$\frac{W_t}{P_t} = \frac{vC_t}{1-N_t} \quad (3)$$

$$Q_t = \beta E_t \left\{ \frac{C_{t+1}^{-\sigma} [(1-N_{t+1})^v]^{1-\sigma}}{C_t^{-\sigma} [(1-N_t)^v]^{1-\sigma}} \frac{P_t}{P_{t+1}} \right\} = \beta E_t \left\{ \frac{C_{t+1}^{-\sigma} [(1-N_{t+1})^v]^{1-\sigma}}{C_t^{-\sigma} [(1-N_t)^v]^{1-\sigma}} \Pi_{t+1}^{-1} \right\} \quad (4)$$

- Log-linearize equation (3) around steady state and interpret the result.
- With steady state values equal to 0 for consumption growth and wage growth, and steady state values of inflation and the nominal interest rate equal to  $\pi$  and  $i$ , respectively, show that the log-linearized version of equation (4), around its steady state, can be written as:

$$c_t = E_t\{c_{t+1}\} - \frac{1}{\sigma + v(\sigma - 1)}(i_t - E_t\{\pi_{t+1}\} - \rho) - \frac{v(\sigma - 1)}{\sigma + v(\sigma - 1)}E_t\{\Delta\omega_{t+1}\}, \quad (5)$$

where  $\frac{1}{\sigma + v(\sigma - 1)} > 0$  (hint: use the solution to 3d).

- Interpret equation (5) and give an intuitive explanation for why consumption now depends on expected real wage growth. How does your answer depend on the size of  $\sigma$ ? In your answer, which should be no more than two pages long, you are not expected to interpret the  $\frac{1}{v(\sigma - 1)}$  part of the second term on the RHS, or the  $\frac{1}{\sigma + v(\sigma - 1)}$  part of the third term on the RHS.

- g) Explain in words how the household's optimization problem will change if we introduce monopolistic competition in this economy (your answer should be based on what you have learned in this course).