

## Exam of the course “Monetary Economics”

*Two hours. Course presentation slides allowed, in paper format, possibly with hand-written annotations (on the slides or on separate sheets). No other document allowed, nor any electronic device (calculator, mobile phone...).*

### 1 Exercise 1 (6.5 points)

Consider the basic New Keynesian model, whose key equilibrium conditions are

$$\begin{aligned}\tilde{y}_t &= \mathbb{E}_t \{\tilde{y}_{t+1}\} - \frac{1}{\sigma} (i_t - \mathbb{E}_t \{\pi_{t+1}\} - r_t^n) && \text{(IS equation),} \\ \pi_t &= \beta \mathbb{E}_t \{\pi_{t+1}\} + \kappa \tilde{y}_t && \text{(Phillips curve),}\end{aligned}$$

where the notations are the same as in the course. Assume that the natural rate of interest follows the exogenous stochastic process

$$r_t^n = \rho + \varepsilon_t^a,$$

where  $\rho \geq 0$  and  $\varepsilon_t^a$  is an i.i.d. shock of variance  $V_a > 0$ . Assume moreover that the central bank observes inflation with some i.i.d. error  $\varepsilon_t^b$  of variance  $V_b > 0$  (orthogonal to  $\varepsilon_t^a$ ), i.e.

$$\pi_t^o = \pi_t + \varepsilon_t^b,$$

where  $\pi_t^o$  denotes observed inflation. Assume finally that the central bank follows the rule

$$i_t = \rho + \phi \pi_t^o,$$

where  $\phi \geq 0$ .

**Question 1** Check that there exists a local equilibrium of the form

$$\begin{bmatrix} \tilde{y}_t \\ \pi_t \\ i_t \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ \rho \end{bmatrix} + \begin{bmatrix} a_y & b_y \\ a_\pi & b_\pi \\ a_i & b_i \end{bmatrix} \begin{bmatrix} \varepsilon_t^a \\ \varepsilon_t^b \end{bmatrix},$$

and determine the values of  $a_y$ ,  $b_y$ ,  $a_\pi$ ,  $b_\pi$ ,  $a_i$ , and  $b_i$ . (As a reminder, any i.i.d. shock  $\varepsilon_t$  is such that  $\mathbb{E}_t \{\varepsilon_{t+k}\} = 0$  for any  $k \geq 1$ .)

**Question 2** Under what condition on  $\phi$  do we have local-equilibrium determinacy? (No computation is needed to answer this question : one can use the results presented in the course. The answer to the previous question is not needed either.) Deduce that under this condition, the local equilibrium studied in the previous question is the unique local equilibrium, i.e. the unique solution in  $(\tilde{y}_t, \pi_t, i_t)$  with finite variance.

**Question 3** Show that the variance of actual inflation, at this equilibrium, is

$$V(\phi) \equiv \frac{\kappa^2 (V_a + \phi^2 V_b)}{(\sigma + \phi\kappa)^2},$$

and that

$$V'(\phi) = \frac{2\kappa^2 f(\phi)}{(\sigma + \phi\kappa)^4}, \quad \text{where} \quad f(\phi) \equiv (\sigma\kappa V_b) \phi^2 + (\sigma^2 V_b - \kappa^2 V_a) \phi - (\sigma\kappa V_a).$$

**Question 4** What value should the central bank choose for  $\phi$  in order to minimize the variance of actual inflation, subject to the constraint obtained in Question 2, in the following two alternative cases : when  $V_a$  is very large compared to  $V_b$ , and when  $V_b$  is very large compared to  $V_a$ ? Interpret.

## 2 Exercise 2 (3.5 points)

The goal of this exercise is to study the determinacy properties of quantitative-easing policies in the basic New Keynesian model with money in the utility function. As a reminder, this model, in the absence of any shock, is characterized by the following log-linearized IS equation, Phillips curve, and money-market-clearing condition :

$$\begin{aligned} \tilde{y}_t &= \mathbb{E}_t \{ \tilde{y}_{t+1} \} - \frac{1}{\sigma} (i_t - \mathbb{E}_t \{ \pi_{t+1} \}), \\ \pi_t &= \beta \mathbb{E}_t \{ \pi_{t+1} \} + \kappa \tilde{y}_t, \\ m_t^s - p_t &= \frac{\sigma}{\nu} \tilde{y}_t - \frac{1}{\nu} i_t, \end{aligned}$$

where the notations are the same as in the course (in particular,  $\sigma > 0$  and  $\nu > 0$ ). We suppose that the central bank's instrument is the money supply  $m_t^s$ .

**Question 1** If the central bank sets  $m_t^s$  exogenously, is there local-equilibrium determinacy? (Answering this question does not require any computation.) Briefly interpret with the Taylor principle.

**Question 2** If the central bank sets  $m_t^s$  according to the money rule  $m_t^s = \phi_p p_t + \phi_y \tilde{y}_t$ , where  $\phi_p < 0$  and  $\phi_y < 0$ , is there local-equilibrium determinacy? (Answering this question does not require any computation.) Briefly interpret again with the Taylor principle.

## 3 Commentary (10 points)

Comment briefly, in the light of the course, upon the following excerpt from the speech entitled “Monetary Policy Analysis and the Development of Federal Reserve Policymaking” made by C.J. Waller – Federal Reserve governor – on October 10, 2023. In so doing, explain in particular, in the context of the New Keynesian framework : (i) how providing more information to the private agents about the monetary-policy framework (the goals of monetary policy, the numerical inflation target, the economic forecasts of individual FOMC members, the reaction function or interest-rate rule) may enhance the central bank's credibility and the effectiveness of monetary policy ; (ii) how anchoring private agents'

expectations about future inflation can help to stabilize current inflation ; and (iii) whether or not this greater transparency would also have been useful before Volcker's disinflation in the early 1980s.

*“In the 25 years since 1998 (...), the FOMC's policy framework has become much more explicit. At the end of 2007, the FOMC began publishing a quarterly Summary of Economic Projections, collecting information on individual meeting participants' forecasts. Then, in January 2012, the FOMC issued a Statement on Longer-Run Goals and Monetary Policy Strategy (...) [which] made the price-stability goal that is part of our congressional mandate more concrete by indicating that Federal Reserve policymakers interpret it as a 2 percent longer-run inflation rate (...).*

*As many observers have noted over the years, the introduction of the 2 percent inflation objective and other formalizations of the Federal Reserve's monetary policy framework actually took place well after disinflation had been achieved under Volcker and consolidated under Greenspan. It might be asked why – with price stability secured by around the mid-1990s – these formalizations were thought necessary. The answer lies in the fact that a well-understood monetary policy regime is needed to make price stability and anchored inflation expectations durable features of the economic environment. Communicating key characteristics of the regime – including the numerical inflation target and policymakers' reaction function – makes it concrete and transparent in the eyes of the general public while also enhancing the central bank's credibility and the effectiveness of monetary policy.”*