Advanced Macroeconomics II, Summer Term 2022/23
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Assignment 2

Please hand in your problem set answers electronically (in the group allocation you have been assigned to) through the 'assignment module' of the WU learn platform, stating your names and student numbers on the problem set. Please submit your answers in one zip file. The submission should include one concise document in which you collect and present all your main answers to the assignments' question(s). Derivations can be hand written, as long as they are legible. Also include all data files that have been used to obtain your answers! Please do not spilt work on this problem set by assigning individual group members to individual questions, but work on all questions together as a group!

Important: Please include the following written statement of confirmation at the beginning of your assignment answers and sign these by all group team members:

We hereby declare that the answers to the given assignment are entirely our own, resulting from our own work effort only.

Our team members contributed to the answers of the assignment in the following proportions:

Name of group member 1: XX%
Name of group member 2: XX%
Name of group member 3: XX% (if appropriate)

Question 1) Transmission of monetary policy shocks in the AS-AD model and the New Keynesian model (6 points)

a. Draw a diagram of an AS-AD model for the case of an AS curve with a mild upward slope. Do not forget to label all axes and curves. Now, consider the case of an expansionary monetary policy shock. Which curve shifts where (IS-LM diagram is not needed), and what are the effects on output and the price level? What happens in the short-run and what in the long-run? Why?

b. Redo the same as in exercise 1a) but with a with an AS curve that has a much steeper slope. Explain what are the differences and *why* do they arise between the mild-slope case and the steep-slope case and how we can interpret them economically?

c. Recall that the NKPC from the baseline New Keynesian model from class is given by:

$$\widehat{\pi}_t = \kappa(\widehat{y}_t - \widehat{y}_t^{flex}) + \beta E_t \widehat{\pi}_{t+1} \tag{1}$$

where $\kappa \equiv \lambda(\sigma + \varphi)$, and where $\lambda = \frac{\theta-1}{\phi}$ under the assumption of Rotemberg price adjustment costs. What happens to the slope of the NKPC as prices become more flexible (lower price adjustment cost parameter ϕ) or as market power of monopolistic competitors decreases (higher elasticity of substitution between varieties, θ). How do your answers here relate to answers from question a.) and b.)? Under which parameter constellations (of ϕ and θ) does monetary policy have large short-run effects?

Question 2) (11 points) **A New Keynesian model with energy** (4.5 points)

Consider extending the New Keynesian model from class to include energy inputs needed for the production of goods. Luckily, nothing changes on the household side, so that the household problem and first order optimality conditions are fully described by slides 29-40 of lecture slides 2.

a. Now turn to the firm side. That is, firms are now assumed to produce using both labor and energy as production inputs, according to a Cobb-Douglas production function:

$$Y_t(i) = A_t N_t(i)^{1-\alpha} EN_t(i)^{\alpha}. \tag{2}$$

The firm's dynamic problem continues to read:

$$\max E_0 \sum_{t=0}^{\infty} \Lambda_{0,t} \left[P_t(i) Y_t(i) - MC_t Y_t(i) - \frac{\phi}{2} \left(\frac{P_t(i)}{P_{t-1}(i)} - 1 \right)^2 P_t Y_t \right], \tag{3}$$

however, the definition of marginal cost, MC_t, has changed. For your convenience, you *do not* need to derive the dynamic FOC w.r.t. the choice of the optimal price, as this is identical as in the baseline NK model. Instead, you *only* need to solve the changed cost minimization problem below, which now requires deriving the first order conditions w.r.t. $N_t(i)$, $EN_t(i)$, and $MC_t(i)$:

$$\min W_t N_t(i) + P_t^E EN_t(i) - MC_t(i) \left[A_t N_t(i)^{1-\alpha} EN_t(i)^{\alpha} - Y_t(i) \right], \tag{4}$$

where P_t^E denotes the (nominal) price of energy, which we will take as exogenously given (i.e. we do not model a supply side for energy, and instead assume that energy is imported from abroad at price P_t^E).
Label the first order conditions of the above expenditure minimization problem w.r.t. $N_t(i)$, $EN_t(i)$, and $MC_t(i)$ equations eq1), eq2) and eq3).
Show that one can derive the optimal labor-to-energy ratio from combining equations eq1) and eq2), and that this ratio only depends on (aggregate) prices, so that the ratio is not firm-i specific.
Show that one can derive an expression for marginal costs that also is the same for all firms i, by combining all three optimality conditions (that is,

by expressing $N_t(i)$ from eq1 and $EN_t(i)$ from eq2 and plugging them in into the production function, eq3) to obtain the relevant expression for $MC_t(i)$. From now on, assume that all firms are identical, so that we can drop the i index.

b. Coding up the non-linear version of the energy-extended NK model:
I uploaded dynare file "NKmodel_nonlin.mod" on the Canvas course website. It codes up the baseline New Keynesian model from class (without energy), based on the set of *non-linear* first order and equilibrium conditions summarized on slides 65-66 of lecture slides 2, together with a basic feedback-to-inflation Taylor rule in its non-linear form, given by $(1+i_t)/\left(1+\bar{i}\right) = (\pi_t)^{\phi_\pi} e^{v_t}$. Use this file (and adopt the parameter values therein) as a basis to coding up the NK model with energy above. To do so, you only need to:

- exchange the expressions for the production function and marginal costs to the ones you found in 2a.)
- re-derive and replace the resource constraint, by following the steps layed out on slide 50 of the lecture notes and using the appropriate expression for (real) profits of the above energy-NK model, $\frac{\Pi_t}{P_t} = Y_t - \frac{W_t}{P_t} N_t - \frac{P_t^E}{P_t} EN_t - \frac{\phi}{2}(\pi_t - 1)^2 Y_t$.
- add the optimal labor-energy ratio derived in 2a.) to your system of equations
- add the exogenous law of motion for the energy price to your system. This exogenous process is given for the real energy price $p_t^E \equiv \frac{P_t^E}{P_t}$, and reads:
$$\log p_t^E = \rho_{PE} \log p_{t-1}^E + \varepsilon_{pe,t}.$$
- assign the following additional model parameters in the energy-extended NK model: $\alpha = 0.05$, $\rho_{PE} = 0.5$. Else leave all other parameters as in file "NKmodel_nonlin.mod".

c. Derive impulse reponses to i) a monetary policy shock and ii) a technology shock. How do they qualitatively differ from the baseline model we have seen in class? Also, iii) present impulse responses to a energy price shock and discuss what and why happens to the macroeconomy.

Question 3) Policy application (5.5 points) Listen to the interview of Ricardo Reis (LSE) on VoxEU on "How did in‡ation get so high?" (https://cepr.org/multimedia/how-did-inflation-get-so-high). In a brief statement or mini-essay of about 300 words (e.g., suppose you work at a central bank and need to consult/brief your superior/governor), talk about a key insight or interesting aspect that you take

away from this interview. In how far does this insight/aspect relate to what you have learned on monetary policy in the baseline New Keynesian model or goes beyond it?