Macroeconomics II, Q&A session

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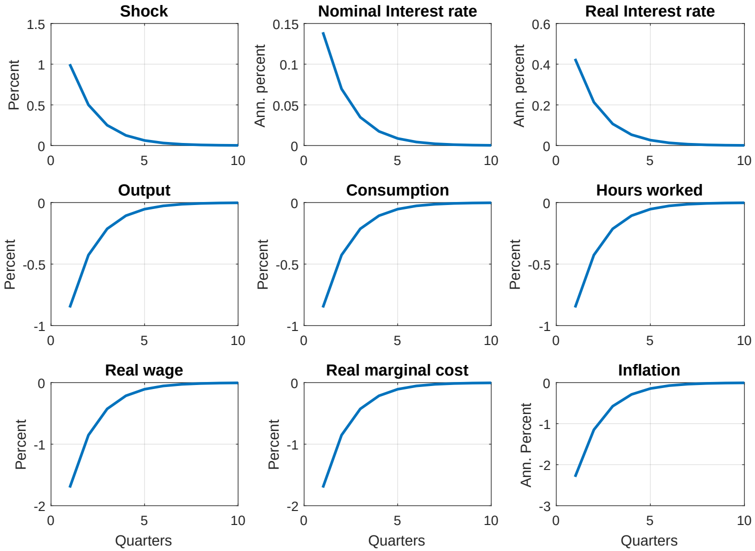
Agenda

1. Clarification of some lecture note material
2. Some questions regarding problem set exercises
3. Some questions regarding old exams

Clarification of some lecture note material

Question: How to use "bounded solution condition" when analyzing IRFs?

- Context: IRF to monetary policy shock in NK model (lecture 3)



IRFs to monetary policy shock: mechanism

- Take as given that $\hat{r}_t$ increases, then

$$\text{Intertemporal hh optimality:} \qquad \hat{c}_t = -(\hat{r}_t) + E_t \hat{c}_{t+1}$$

implies $\Delta E_t c_{t+1}$ is positive

- **Bounded solution** $\Rightarrow \hat{c}_t < 0$
- Market clearing $\hat{c}_t = \hat{y}_t = \hat{n}_t < 0$
  - $\Rightarrow$ we may think of the output drop as being caused by drop in aggregate demand
- How is this consistent with optimal labor supply? Intratemporal optimality condition:

$$\text{Intratemporal hh optimality:} \qquad \hat{\omega}_t = \hat{c}_t + \varphi \hat{n}_t$$

- $\hat{n}_t < 0$ only if $\hat{\omega}_t < \hat{y}_t < 0$
  - Wages need to respond a lot!
- $\hat{\omega}_t < 0 \Rightarrow \hat{m}c_t < 0 \Rightarrow \beta E_t \pi_{t+1} - \pi_t \approx \Delta \pi_{t+1} > 0$ from the Phillips curve
- Bounded solution $\Rightarrow \hat{\pi}_t < 0$
- Notice how the assumption of a "bounded solution" enters the analysis

bounded solution

- "Bounded solution" means that no IRF diverge
- Ignoring "oscillation solutions" (they are only possible with higher order AR(p) solutions - not possible in these models), the solution must converge to some steady state
- Moreover, we also know that steady state is unique
- Therefore, the solution must have $\hat{c} \to 0$ in the long run
- With $\Delta E_t \hat{c}_{t+1} > 0$ for all t, we must have $\hat{c}_0 < 0$

Some questions regarding problem set exercises

Question: How to interpret IRFs in the NK model?

- Context: Problem set 2, question 1 (government spending shocks).

The vanilla equilibrium system with sticky prices

$$
\begin{aligned}
\text{Intratemporal hh optimality:} \quad & \hat{\omega}_t = \hat{c}_t + \varphi \hat{n}_t \\
\text{Intertemporal hh optimality:} \quad & \hat{c}_t = -(\hat{i}_t - E_t \pi_{t+1}) + E_t \hat{c}_{t+1} \\
\text{Firm optimality:} \quad & \pi_t = \beta E_t \pi_{t+1} + \lambda \widehat{mc}_t \\
\text{Marginal cost:} \quad & \widehat{mc}_t = \hat{\omega}_t \\
\text{Goods clearing:} \quad & \hat{c}_t = \hat{y}_t \\
\text{Bonds clearing:} \quad & \hat{b}_t = 0 \\
\text{Labor clearing:} \quad & \hat{y}_t = \hat{n}_t \\
\text{Mon policy rule:} \quad & \hat{i}_t = \phi \pi_t .
\end{aligned}
$$

The equilibrium system with sticky prices and gov spending

$$\begin{aligned}
\text{Intratemporal hh optimality:} \quad & \hat{\omega}_t = \hat{c}_t + \varphi \hat{n}_t \\
\text{Intertemporal hh optimality:} \quad & \hat{c}_t = -(\hat{i}_t - E_t \pi_{t+1}) + E_t \hat{c}_{t+1} \\
\text{Firm optimality:} \quad & \pi_t = \beta E_t \pi_{t+1} + \lambda \widehat{mc}_t \\
\text{Marginal cost:} \quad & \widehat{mc}_t = \hat{\omega}_t \\
\text{Goods clearing:} \quad & \bar{c}\hat{c}_t + \bar{g}\hat{g}_t = \hat{y}_t \\
\text{Bonds clearing:} \quad & \hat{b}_t = 0 \\
\text{Labor clearing:} \quad & \hat{y}_t = \hat{n}_t \\
\text{Mon policy rule:} \quad & \hat{i}_t = \phi \pi_t. \\
\text{Spe policy rule:} \quad & \hat{g}_t = \rho g_{t-1} + \epsilon_t^g.
\end{aligned}$$

where

$$\bar{c} = \frac{C}{Y}, \bar{g} = \frac{G}{Y}$$

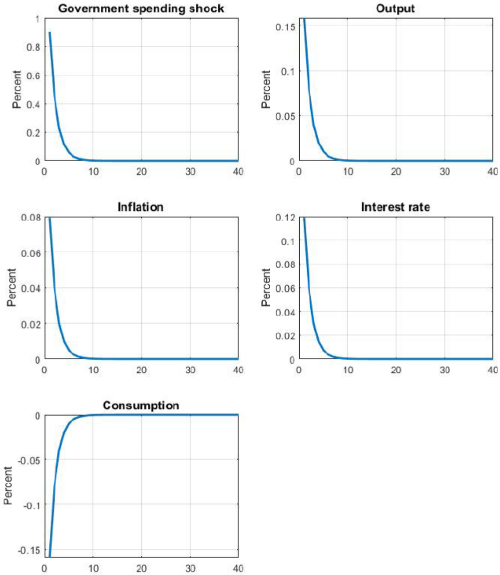
The equilibrium system with flexible prices and gov spending

$$
\begin{aligned}
\text{Intratemporal hh optimality:} \quad & \hat{\omega}_t = \hat{c}_t + \varphi \hat{n}_t \\
\text{Intertemporal hh optimality:} \quad & \hat{c}_t = -(\hat{i}_t - E_t \pi_{t+1}) + E_t \hat{c}_{t+1} \\
\text{Firm optimality:} \quad & \widehat{mc}_t = 0 \\
\text{Marginal cost:} \quad & \widehat{mc}_t = \hat{\omega}_t \\
\text{Goods clearing:} \quad & \bar{c}\hat{c}_t + \bar{g}\hat{g}_t = \hat{y}_t \\
\text{Bonds clearing:} \quad & \hat{b}_t = 0 \\
\text{Labor clearing:} \quad & \hat{y}_t = \hat{n}_t \\
\text{Mon policy rule:} \quad & \hat{i}_t = \phi \pi_t. \\
\text{Spe policy rule:} \quad & \hat{g}_t = \rho g_{t-1} + \epsilon_t^g.
\end{aligned}
$$

where

$$\bar{c} = \frac{C}{Y}, \bar{g} = \frac{G}{Y}$$

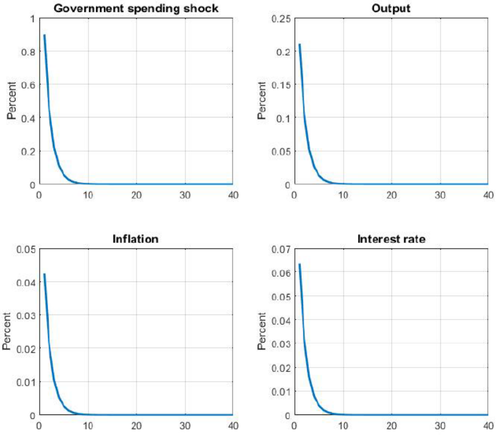
IRFs in the flex price equilibrium



Interpretation

- Direct effect of government spending shock: $\hat{g}_t$ up $\hat{c}_t$ down (due to tax financing)
  - Always start here!
  - Similar to when you analyze (positive) TFP shocks, direct effect: output up.
- Equilibrium effects:
  - Household intratemporal optimality: $\hat{c}_t$ down $\rightarrow$ $\hat{n}_t$ up ("wealth effect")
  - Bounded solution: $\hat{c}_t$ down $\rightarrow \Delta\hat{c}_{t+1} > 0$
  - Household intertemporal optimality: $\Delta\hat{c}_{t+1} > 0 \Rightarrow \hat{i}_t - E_t\pi_{t+1}$ up
  - Policy rule: $\hat{i}_t - E_t\pi_{t+1}$ up $\rightarrow$ i_t up and π_t up
    - ⋆ Policy rule implies that interest rates and (expected) inflation always moves in the same direction.

IRFs in the sticky-price equilibrium



Interpretation

- Direct effect of government spending shock: $\hat{g}_t$ up $\hat{c}_t$ down (due to tax financing)

- Equilibrium effects in flex-price equilibrium:
  - Household intratemporal optimality: $\hat{c}_t$ down $\rightarrow \hat{n}_t$ up ("wealth effect")
  - Bounded solution: $\hat{c}_t$ down $\rightarrow \Delta\hat{c}_{t+1} > 0$
  - Household intertemporal optimality: $\Delta\hat{c}_{t+1} > 0 \Rightarrow \hat{i}_t - E_t\pi_{t+1}$ up
  - Policy rule: $\hat{i}_t - E_t\pi_{t+1}$ up $\rightarrow i_t$ up and π_t up

- Added equilibrium effects in sticky-price equilibrium:
  - With sticky prices, what changes is

$$\text{Firm optimality:} \qquad \pi_t = \beta E_t\pi_{t+1} + \lambda\widehat{mc}_t$$

  - Bounded solution: π_t up $\rightarrow \Delta E_t\pi_{t+1}$ down
  - Firm optimality: $\Delta E_t\pi_{t+}1$ down $\rightarrow \widehat{mc}_t = \hat{\omega}_t$ up
  - Household intratemporal optimality: $\hat{\omega}_t$ up $\rightarrow \hat{n}_t$ down
  - The fall in wages offset the wealth effect in the labor-supply decision, making the equilibrium response of output smaller.

- Note: the increase in inflation was key to this argument!
  - The central bank could have offsetted the increase in inflation if it met the shock with increasing the interest rate more, i.e., a higher coeffcient ϕ
  - In this sense, the larger government spending multiplier under sticky prices is a consequence of "loose" monetary policy
  - Remark: This is also why the NK model predicts that spending multipliers may be very high when monetary policy is stuck at the ZLB (Woodford AEJmacro 2011, and a very large follow-up literature)

Some questions regarding old exams

Questions

- August 2022 Q3: How are two steady states possible?
- March 2022 Q1: How to sketch IRFs?
- March 2022 Q2 (also March 2022 Q1): How to use guess-and-verify?
- March 2022 Q3: How to solve for the Hosios condition?
- March 2022 Q4: How to solve for changes in aggregate welfare?