About TA sections:

TAs: Ekaterina Zubova (ez268@cornell.edu), Zheyang Zhu (zz792@cornell.edu)

Section time and location: 8:40am - 9:55am Uris Hall 262 (section 201), Goldwin Smith Hall 236 (section 202)

Office hours: Tuesdays 5-7 pm in Uris Hall 451 (Ekaterina), Thursdays 5-7 pm in Uris Hall 429 (Zheyang). Other times available by appointment (just send us an email!)

Our plan for today:

1 Incorporating news in the RBC model

1.1 Model

Recall the RBC model that we introduced in one of the previous sections:

The representative household (RH) solves the following problem:

$$\max_{(C_t)_{t\geq 0},(H_t)_{t\geq 0},(I_t)_{t\geq 0},(K_{t+1})_{t\geq 0}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\log(C_t) - \chi H_t\right]$$

such that

$$C_t + I_t = R_t K_t + W_t H_t$$

$$K_{t+1} = (1-\delta)K_t + I_t$$

The RH takes a bunch of things as given: $(R_t)_{t\geq 0}$, $(W_t)_{t\geq 0}$ and K_0

The firm solves a static profit maximization problem:

$$\max_{K_t,H_t} A_t K_t^{\alpha} H_t^{1-\alpha} - W_t H_t - R_t K_t$$

where A_t is the total factor productivity (TFP). (Previously, we also saw a version with labor-augmenting technology).

Earlier we assumed that productivity evolves according to AR(1) process:

$$\log(A_t) = \rho \log(A_{t-1}) + \sigma_a \epsilon_t$$

1.2 Incorporating news shocks

In a standard RBC model without news shocks, agents only respond to current surprise shocks. By incorporating news shocks, the model accounts for fluctuations driven by expectations, allowing for anticipation effects such as investment or labor market adjustments that precede actual productivity changes.

To incorporate news shocks, we need to change the expression above to represent anticipated information about future changes in productivity. To do this, we need to expand the state space to include both contemporaneous shocks and future shocks that are anticipated today but materialize in subsequent periods.

For example, if the news about productivity changes in period t arrived in period $t-1$, we will write this as (WLOG, assume $\sigma_a = 1$):

$$a_t = \rho a_{t-1} + \varepsilon_t^0 + \varepsilon_{t-1}^1,$$

where

- $a_t \equiv log(A_t)$,
- ε_t^0 is the unanticipated contemporaneous shock, which affects productivity unexpectedly in the current period t,
- ε_{t-1}^1 is the anticipated news shock from the previous period, representing information received in period $t-1$ about changes expected to occur in period t.

Intuition:

- **Unanticipated shocks** represent sudden and unexpected changes in productivity that agents could not foresee or prepare for. For example, sudden natural disasters.
- **Anticipated shocks** allow agents to form expectations about future changes in productivity. When agents receive news about a future improvement or decline, they can adjust their decisions (e.g., consumption, investment, labor supply) in the current period to account for expected changes in the next period. For example, planned policy changes.

Introducing this combination of shocks allows us to explore how **forward-looking behavior** shapes economic outcomes.

We can also rewrite the expression above in the matrix form $\mathbf{x}_t = \mathbf{A}\mathbf{x}_{t-1} + \varepsilon_t$ where $\mathbf{x}_t$ is the state vector, $\mathbf{A}$ is the transition matrix, and ε_t is the vector of shocks. In this case, this will look as follows:

$$\begin{bmatrix} a_t \\ \varepsilon_t^1 \end{bmatrix} = \underbrace{\begin{bmatrix} \rho & 1 \\ 0 & 0 \end{bmatrix}}_{A} \begin{bmatrix} a_{t-1} \\ \varepsilon_{t-1}^1 \end{bmatrix} + \begin{bmatrix} \varepsilon_t^0 \\ \varepsilon_t^1 \end{bmatrix}$$

More generally, we can further expand the state space to incorporate an arbitrary horizon h (how far into the future agents can anticipate shocks), capturing the propagation of news shocks over multiple periods. Then, the same expression in matrix form will look like:

$$\begin{bmatrix} a_t \\ \varepsilon_t^1 \\ \varepsilon_t^2 \\ \vdots \\ \varepsilon_t^h \end{bmatrix} = \begin{bmatrix} \rho & 1 & 0 & 0 & \cdots & 0 \\ 0 & 0 & 1 & 0 & \cdots & 0 \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & 0 & \cdots & 1 \\ 0 & 0 & 0 & 0 & \cdots & 0 \end{bmatrix} \begin{bmatrix} a_{t-1} \\ \varepsilon_{t-1}^1 \\ \varepsilon_{t-1}^2 \\ \vdots \\ \varepsilon_{t-1}^h \end{bmatrix} + \begin{bmatrix} \varepsilon_t^0 \\ \varepsilon_t^1 \\ \varepsilon_t^2 \\ \vdots \\ \varepsilon_t^h \end{bmatrix}$$

2 Implementing the model in MATLAB

The implementation code is available as a zipped file on Canvas titled **ECON6130_TA12**. Similar to previous assignments, the zipped file includes a folder containing helper functions, a function file (**parameters.m**) for storing model parameters, and two scripts (**linear_model_surprise.m** and **linear_model_news.m**) that generate two functions. Additionally, the folder contains the generated functions (**model_df_surprise.m** and **model_df_news.m**) and the main program script (**main_prog.m**).

2.1 Key difference

The codes are based on the previous log-linearization method. The key difference is that A_t is now treated as a jump variable while A_{t-1} is treated as a state variable. All the shocks $\mathcal{E}_t^0$ ($\equiv e^{\epsilon_t^0}$), $\mathcal{E}_t^1$ and so on are also treated as state variables.

2.2 RBC model with surprise shock

Following these changes, we need to adjust our model equations accordingly. With the surprise shock, the technology equation becomes:

$$\log(A_t) = \rho \log(A_{t-1}) + \sigma_a log(\mathcal{E}_t^0).$$

In MATLAB, for indexing reasons, $\mathcal{E}_t^0$ is referred to as EPS1. We further modify the technology equation as "f(end+1) = log(A) - rho * log(AL) - log(EPS(1))". We make sure the A is consistent by imposing "f(end+1) = AL_p - A". We ensure that shocks are zero in expectation by imposing "f(end+1) = log(EPS1_p)".

Examining the impulse response to the surprise shock in Figure 1, we observe that EPS1 represents a shock that lasts for only one period. A is impacted by EPS1 at time 0, and the effect gradually fades over time. Following the surprise shock at time 0, consumption, labor, investment, and output all respond positively in the same direction upon impact, which aligns with data.

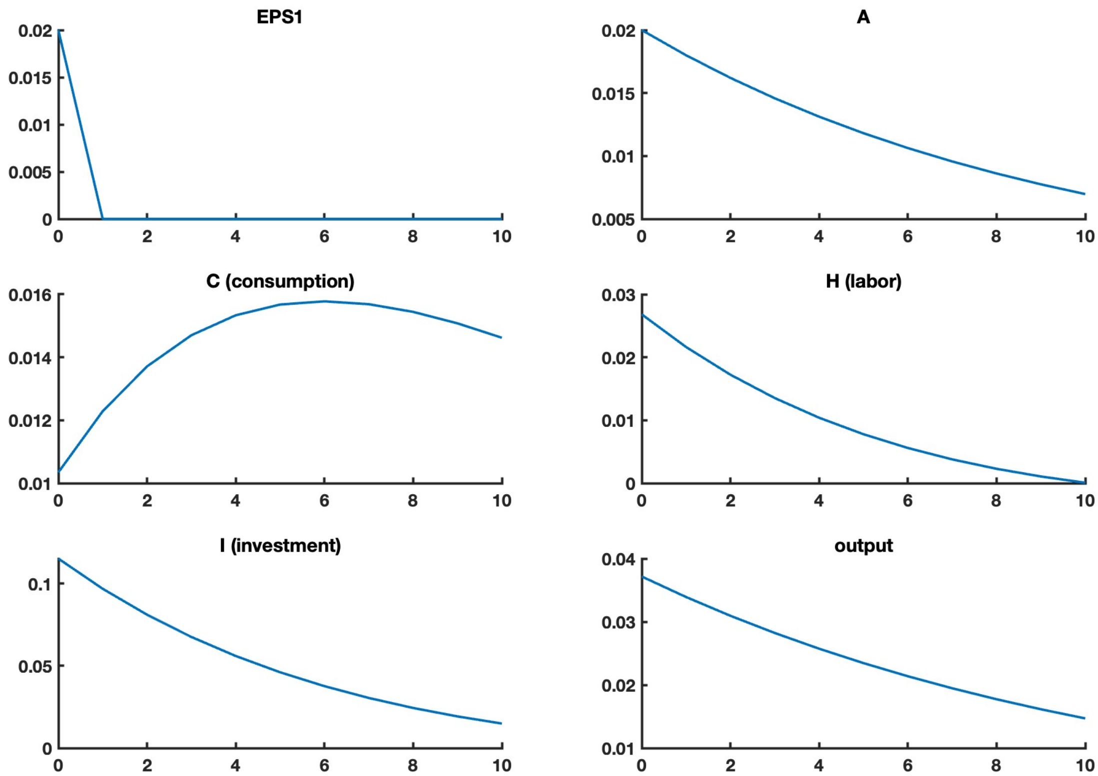

Figure 1: Impulse response to a surprise shock

2.3 RBC model with news shock

We consider a news shock known two periods before. With the news shock, the technology equation becomes:

$$\log(A_t) = \rho \log(A_{t-1}) + \sigma_a log(\mathcal{E}^2_{t-2}).$$

In MATLAB, for indexing reasons, $\mathcal{E}^0_t$ is referred to as EPS1. We further modify the technology equation as "f(end+1) = log(A) - rho * log(AL) - log(EPS(1))". We make sure the A is consistent by imposing "f(end+1) = AL_p - A". We ensure that shocks are consistent by imposing "f(end+1) = EPS1_p - EPS2" and "f(end+1) = EPS2_p - EPS3". We ensure that shocks are zero in expectation by imposing "f(end+1) = log(EPS3_p)".

Examining the impulse response to the news shock in Figure 2, we observe that EPS1, EPS2, and EPS3 represent shocks that last for only one period each. The shock materializes at time 2: A is shocked by EPS1 at time 2, and its impact gradually diminishes over time. Following the news shock at time 0, consumption rises positively at time 0, while labor, investment, and output decline at time 0. This divergence - where consumption, labor, investment, and output do not move in the same direction - does not align with data.

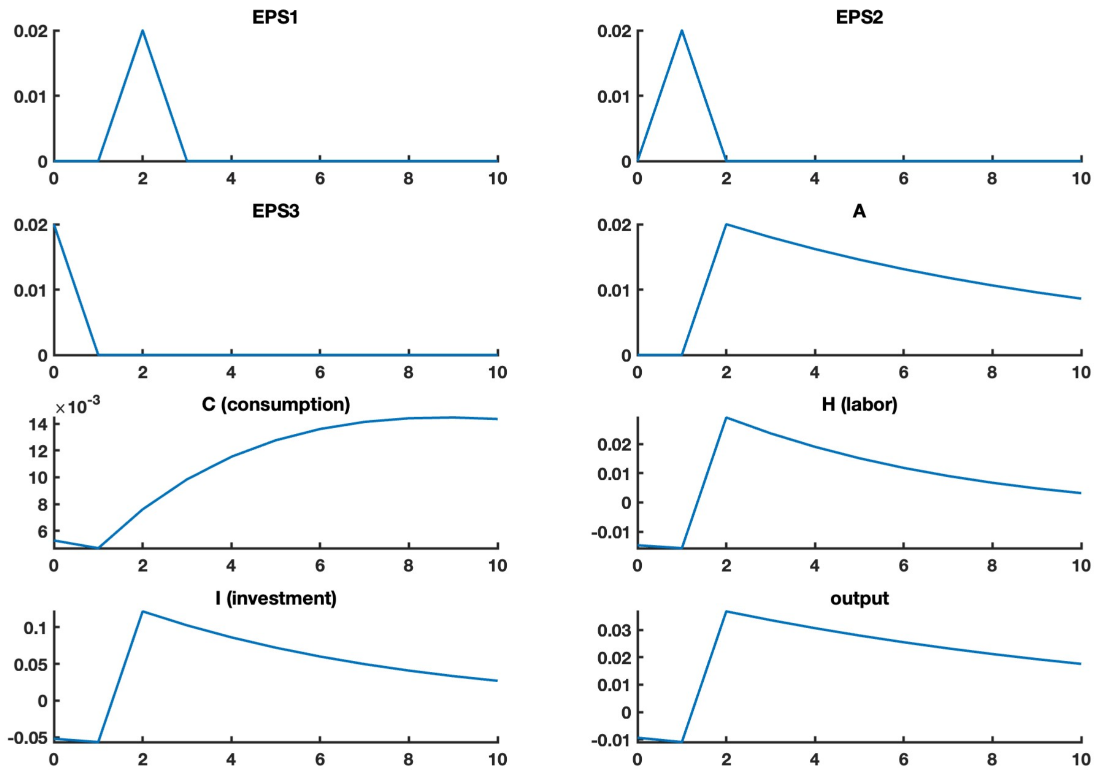

Figure 2: Impulse response to a news shock