

Lecture 4

Monetary policy

Adrien Auclert (Stanford University)

KU Leuven Minicourse

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So far: The canonical HANK model & fiscal policy

Now: Closed economy monetary policy

We keep our focus on real interest rate rules for simplicity

- 1 Review of monetary policy in the standard NK model
- 2 Monetary policy in the canonical HANK model
- 3 Direct and indirect effects of monetary policy
- 4 Takeaway

Review of monetary policy in the standard NK model

- Recall the standard 3-equation NK model
 - separable preferences, sticky prices or wages, perfect foresight

$$c_t = c_{t+1} - \sigma^{-1} (i_t - \pi_{t+1}) \quad (\text{EE})$$

$$\pi_t = \kappa c_t + \beta \pi_{t+1} \quad (\text{NKPC})$$

$$i_t = \pi_{t+1} + \epsilon_t \quad (\text{r-rule})$$

- Taylor rule instead of (**r-rule**): $i_t = \phi \pi_t + \epsilon_t$ (usually $\phi > 1$)

Monetary propagation in the NK model

$$c_t = c_{t+1} - \sigma^{-1} (i_t - \pi_{t+1}) \quad (\text{EE})$$

$$\pi_t = \kappa c_t + \beta \pi_{t+1} \quad (\text{NKPC})$$

$$i_t = \pi_{t+1} + \epsilon_t \quad (\text{r-rule})$$

What does a **monetary policy shock** do, e.g. $\epsilon_t \downarrow$?

1. expansion in c_t so output $y_t \uparrow$, inflation $\pi_t \uparrow$
2. far out shocks to ϵ_t with large t are not dampened (“forward guidance puzzle”)

Two big questions re ...

- **transmission into consumption:** 100% via Euler equation (implausible?)
- **output response:** forward guidance puzzle, model too forward looking

HANK solutions?

Major goal of early HANK papers: solve these two issues!

- **Auclert (2019), Kaplan et al. (2018)**: indirect channels become important for monetary transmission (e.g. redistribution or labor income)
- **McKay et al. (2016)**: borrowing constraints make consumption less forward looking $\Rightarrow$ get something like

$$c_t = \delta c_{t+1} - \sigma^{-1}(i_t - \pi_{t+1}) \quad \text{with } \delta < 1 \quad (\text{DEE})$$

This would dampen forward guidance!

Next: What HANK actually does!

Monetary policy in the canonical HANK model

Setting up the model

- Take canonical HANK model, but abstract from fiscal policy
 - $T = \tau = G = B = 0$
 - but allow agents to borrow from each other: $\underline{a} < 0$ (as in Huggett model)
 - later bring back government to study monetary-fiscal interactions
- Real rate rule: monetary policy sets $r_t^{ante} = i_t - \pi_{t+1}$ directly
- Ask two questions:
 1. Output response relative to RA? (Magnitude? Any “discounting”?)
 2. Transmission channels relative to RA?

We'll start with 1.

Back to our equilibrium conditions

Under these assumptions, the canonical HANK model can just be written as:

$$\begin{aligned} \max_{c_{it}} \quad & \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t (u(c_{it}) - v(N_t)) \\ c_{it} + a_{it} & \leq (1 + r_{t-1}^{ante}) a_{it-1} + e_{it} Y_t \\ a_{it} & \geq \underline{a} \end{aligned}$$

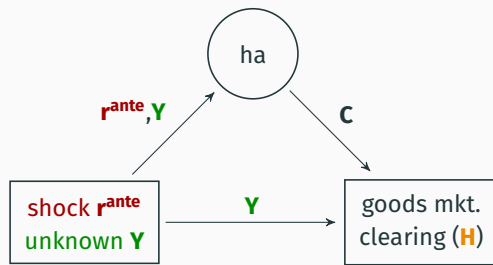
with

$$\begin{aligned} C_t & \equiv \int c_{it} di = Y_t = N_t \\ A_t & \equiv \int a_{it} di = 0 \end{aligned}$$

That's it!

DAG of this model

Let's visualize this as a DAG:



Here again, simple fixed point:

$$C_t(\{r_s^{ante}, Y_s\}) = Y_t$$

Ex-ante vs ex-post r

- In practice, we usually write HetBlocks with “ex-post r ” convention, i.e. here:

$$\begin{aligned} \max_{c_{it}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t (u(c_{it}) - v(N_t)) \\ c_{it} + a_{it} \leq (1 + r_t)a_{it-1} + s_{it}Y_t \\ a_{it} \geq \underline{a} \end{aligned}$$

- This is more general: allows us to handle valuation effects (see next lecture)
- Here there are no valuation effects, so we just have

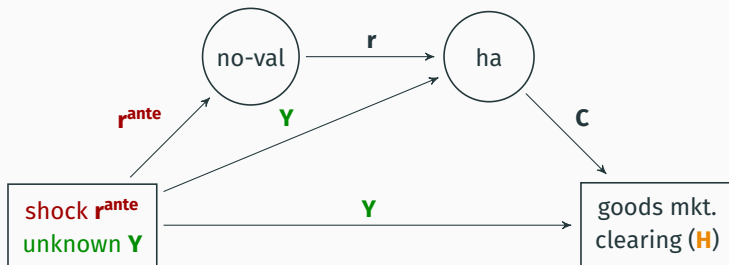
$$r_t = r_{t-1}^{ante} \quad t \geq 1$$

$$r_0 = r_{ss}$$

- This adds one “no valuation” block to the DAG

DAG including the valuation block

Our new DAG is:



If we are fancy, we could use CombinedBlock in SSJ to do the convolution

$$\tilde{\mathcal{C}}_t(\{r_s^{ante}, Y_s\}) \equiv \mathcal{C}_t(\{r_j(r_s^{ante}), Y_s\})$$

So that we are back to our simple fixed point:

$$\tilde{\mathcal{C}}_t(\{r_s^{ante}, Y_s\}) = Y_t$$

Jacobians again

- As in fiscal lecture, let's linearize this sequence space equation
- Define $d\mathbf{r} \equiv (dr_0^{ante}, dr_1^{ante}, \dots)$, and let $d\mathbf{Y} = (dY_0, dY_1, \dots)$ as before. Define Jacobian $\mathbf{M}^r \equiv (\partial \tilde{C}_t / \partial r_s^{ante})_{t,s}$ capturing direct effect of r on C . Then:

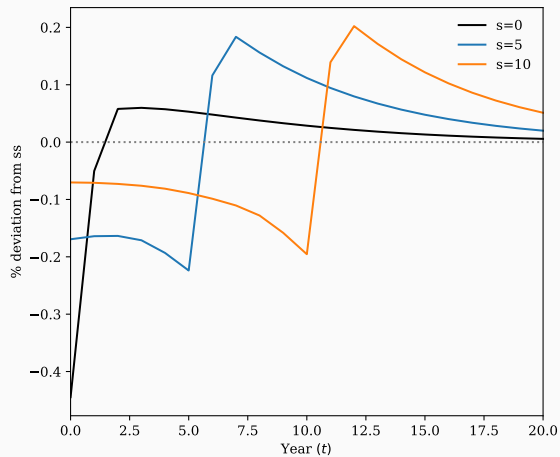
$$d\mathbf{Y} = \mathbf{M}^r d\mathbf{r} + \mathbf{M} d\mathbf{Y}$$

- Almost like the IKC, except that partial eqbm demand shock is no longer coming from fiscal policy, $d\mathbf{G} - \mathbf{M}d\mathbf{T}$, but instead from monetary policy!
- Just as with fiscal, the PE demand shock has zero NPV (Why?)
- General solution uses same linear mapping $\mathcal{M}$ (recall “ $(I - M)^{-1}$ ”)

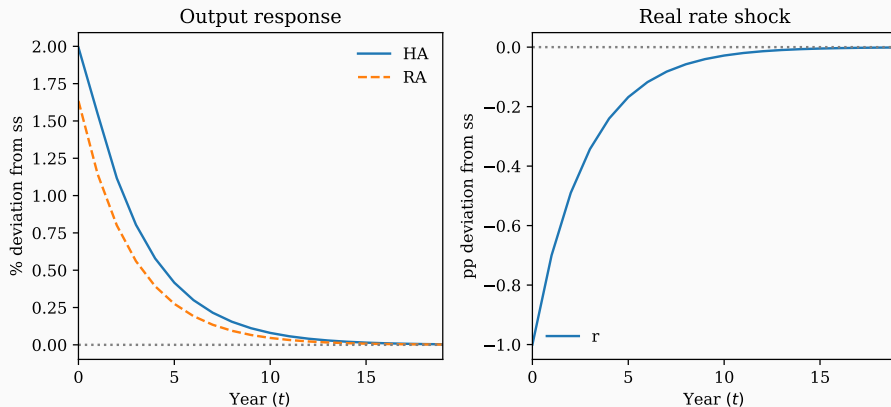
$$d\mathbf{Y} = \mathcal{M} \mathbf{M}^r d\mathbf{r}$$

Next: Let's visualize $\mathbf{M}^r$; then the solution $d\mathbf{Y}$ for an AR(1) shock to $d\mathbf{r}$

Columns of Jacobian $\mathbf{M}^r$



Monetary policy shock in HA (AR(1) with $\rho = 0.7$)



- HA > RA! Interesting! But why?

Benchmark result with zero liquidity

- One way to make progress is to simplify the model $\Rightarrow$ ZL model: $\underline{a} \rightarrow 0$
- Recall that in ss only Euler equation of agents in high income state $\bar{s}$ holds

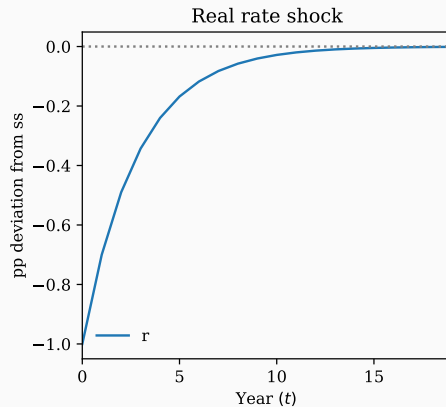
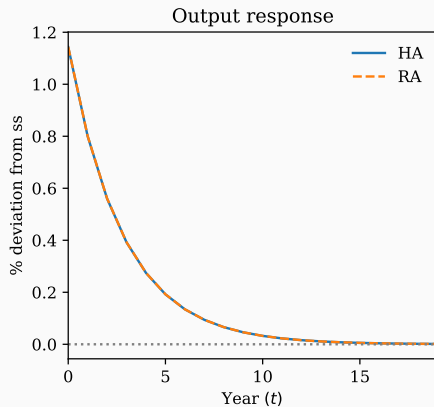
$$(Y_t \bar{s})^{-\sigma} = \beta (1 + r_t) \mathbb{E}_t \left[(Y_{t+1} s')^{-\sigma} | \bar{s} \right]$$

- Define $\bar{\rho} \equiv \mathbb{E} \left[(s' / \bar{s})^{-\sigma} | \bar{s} \right]$. Then, we always have

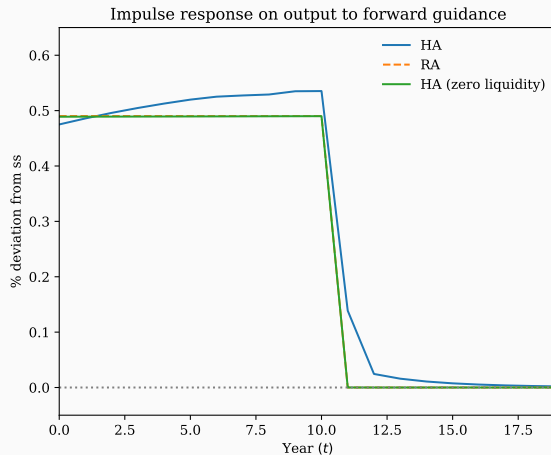
$$Y_t^{-\sigma} = \beta \bar{\rho} (1 + r_t) Y_{t+1}^{-\sigma} \quad \Rightarrow \quad y_t = y_{t+1} - \sigma^{-1} (r_t - \log(\beta \bar{\rho}))$$

- **This is like our representative agent Euler equation!**
 - HA = RA with effective discount factor $\beta \bar{\rho}$
 - $\rightarrow$ **Werning (2015)**'s **neutrality result** for zero liquidity and acyclical income risk
- In particular: No discounting in log-linearized Euler equation!

Neutrality for monetary policy in the ZL limit



Neutrality also implies the forward guidance puzzle is not solved by HA



Summary: Output response of monetary policy in HA

- No robust result that $HA \neq RA$!
 - in fact, with zero liquidity, we showed that $HA = RA$!
 - forward guidance can be equally powerful
- But how can that be, given that HA breaks the Euler equation?
- **Next: study transmission channels**

Direct and indirect effects of monetary policy

Direct and indirect effects

- To see what's going on, let's go back to our IKC-like equation:

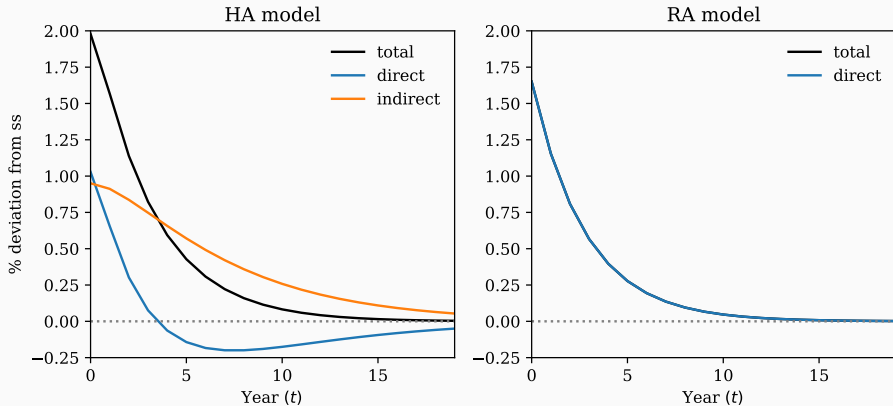
$$d\mathbf{Y} = d\mathbf{C} = \underbrace{\mathbf{M}^r \cdot d\mathbf{r}}_{\text{Direct effect}} \downarrow + \underbrace{\mathbf{M} \cdot d\mathbf{Y}}_{\text{Indirect effect}} \uparrow$$

- Two competing effects** of market incompleteness! direct $\downarrow$, indirect $\uparrow$
[Kaplan et al. (2018) showed this in their two-asset HA model]
- Why? High MPCs make C more sensitive to Y but also **less sensitive to r**
 - cf Auclert (2019): substitution effect of dr scales with $-\sigma^{-1}(1 - MPC)$
 - In ZL model above, can actually prove that $\mathbf{M}^r = -\sigma^{-1}(\mathbf{I} - \mathbf{M})\mathbf{U}$ so [new result!]

$$d\mathbf{C} = -\sigma^{-1}(\mathbf{I} - \mathbf{M})\mathbf{U} \cdot d\mathbf{r} + \mathbf{M} \cdot d\mathbf{Y}$$

Decomposition into direct and indirect effects

- Let's implement $d\mathbf{C} = \mathbf{M}^r d\mathbf{r} + \mathbf{M} \cdot d\mathbf{Y}$ in our canonical HA model:



Takeaway

Takeaway: Monetary policy with heterogeneous agents

1. HA model does not imply robustly different output response
 2. But it *does* change transmission: indirect effects are more important!
- This is the main result in KMV. Why do we care about that per se?
 - KMV: labor & financial market institutions matter more than we thought
 - We'll see other reasons for why we should care in the next lecture

References

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