Lecture 5
Monetary policy topics

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What's next

We just started scratching the surface of monetary policy in HANK

Now: We go a little deeper by exploring a few key topics in the literature

Roadmap

1. Cyclical income risk
2. Maturity structure
3. Fiscal policy
4. Investment
5. Nominal assets
6. Takeaway

Cyclical income risk

Introducing cyclical income risk

- A simple way to introduce cyclical income risk by adopting different labor allocation rule. Auclert and Rognlie (2018) propose

$$n_{it} = Y_t \frac{(e_{it})^{\zeta \log Y_t}}{\mathbb{E}\left[e_i^{1+\zeta \log Y_t}\right]} \equiv Y_t \Gamma\left(e_{it}, Y_t\right)$$

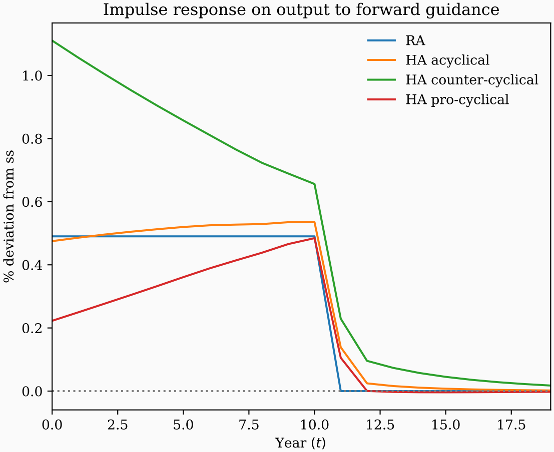
- Distribution of income $y_{it} \equiv e_{it} n_{it}$ now reacts to monetary policy

$$\text{sd}\left(\log y_{it}\right) = \left(1 + \zeta \log Y_t\right) \text{sd}\left(\log e_i\right)$$

  - $\zeta > 0$: procyclical inequality and income risk
  - $\zeta < 0$: countercyclical inequality and income risk
  - $\zeta = 0$ is benchmark from above (acyclical inequality & risk)
- Matters because:
  - current shocks redistribute between different MPCs ("cyclical inequality")
  - future shocks change income risk ("cyclical risk")

Countercyclical income risk makes the forward guidance puzzle worse!

- Consider a r_T shock with three calibrations for ζ in HA model



Zero liquidity limit with cyclical income risk

details

What's going on? In ZL limit, we get an **exact** discounted Euler equation

$$y_t = \delta \cdot \mathbb{E}_t[y_{t+1}] - \sigma^{-1} \cdot \text{const} \cdot (r_{t+1} - \log(\beta\overline{\rho}))$$

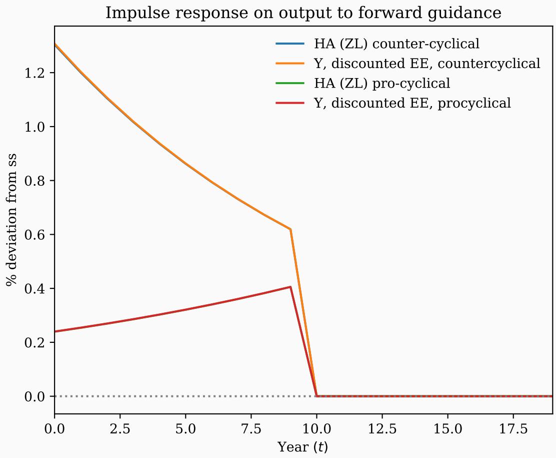
where δ depends on cyclicality of income risk ζ.

1. Dynamic discounting ($\delta < 1$) $\Leftrightarrow$ $\zeta > 0$ procyclical risk (less common)
2. Dynamic amplification ($\delta > 1$) $\Leftrightarrow$ $\zeta < 0$ countercyclical risk (more common)
   - microfound w/ u: Ravn and Sterk (2017), den Haan et al. (2018), Challe (2020)
   - lots of evidence: Storesletten et al. (2004), Guvenen et al. (2014)
3. Dynamic neutrality ($\delta = 1$) $\Leftrightarrow$ $\zeta = 0$ acyclical risk, as in Werning

Why? Precautionary savings. Think about logic of discounted Euler equation.

Forward guidance in the ZL model

- In the empirically plausible case, the fwd guidance puzzle is **aggravated**!
  Bilbiie (2021), Acharya and Dogra (2020)



Indirect ways to make income risk cyclical

- In richer models income of agents typically involves multiple components,

$$y_{it} = \frac{W_t}{P_t} n_{it} s_{it} - \underbrace{\tau_{it}}_{\text{taxes}} + \underbrace{T_{it}}_{\text{transfers}}$$

- These also matter for cyclicality of income risk
- For example, suppose taxes are set to keep balanced budget, $\tau_t \equiv \int \tau_{it} di = r_t B$ and transfers T_t are dividends from firms with sticky prices
  $\Rightarrow$ both τ_t and T_t fall after expansionary r_t (why?)
- If τ_t allocated to highest income state and T_t to all $\Rightarrow$ procyclical risk!
- These are the assumptions in McKay et al. (2016).
  - Reason why that paper "solves" the forward guidance puzzle!

Summary: Cyclical income risk

- Cyclical income risk matters
- Procyclical income risk $\Rightarrow$ weakens monetary policy + fwd guidance
  - … but not empirically supported
- Countercyclical income risk is empirically more plausible
  - … but aggravates forward guidance puzzle!

Maturity structure

So far: agents trade short term assets. What if longer maturities / duration?

For tractability, assume "Calvo bonds":

- buy one bond today for q_t, get stream of real payments $1, \delta, \delta^2, \ldots$

New household problem:

$$\begin{aligned} V_t(\lambda_-, e) &= \max u(c) + \beta \mathbb{E}\left[V_{t+1}(\lambda, e') \,|e\right] \\ c + q_t \lambda &= (1 + \delta q_t)\lambda_- + eY_t \\ q_t \lambda &\geq \underline{a} \end{aligned}$$

where $\lambda =$ total number of bonds (total current coupon). No arbitrage:

$$q_t = \frac{1 + \delta q_{t+1}}{1 + r_t^{ante}}$$

Steady state and dynamics

In steady state, we can rewrite constraints as

$$\begin{aligned} c + q\lambda &= (1+r)\, q\lambda_- + eY \\ q\lambda &\geq \underline{a} \end{aligned}$$

Redefining $a \equiv q\lambda$ means steady state is identical given $\underline{a}$, r, β.

Same argument applies during transitions too, for $t \geq 1$: constraints are independent of maturity!

What about date $t = 0$? **Revaluation effect !**

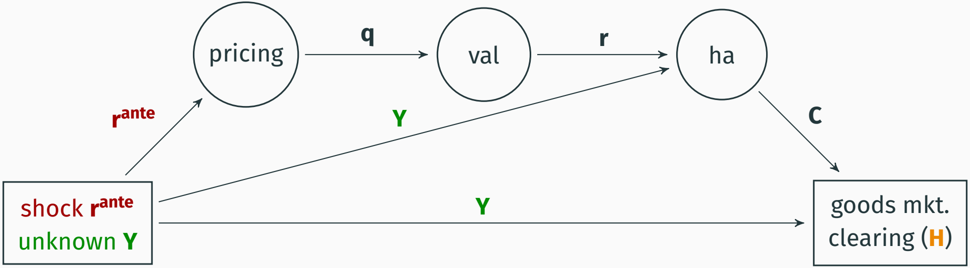
$$1 + r_0 = (1 + r_{ss}) \frac{1 + \delta q_0}{1 + \delta q_{ss}} = \frac{1 + \delta q_0}{q_{ss}} \neq 1 + r_0^{ante} \tag{1}$$

Handle this using the hh block in its ex-post formulation, plus (1) and

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

DAG for the long-bonds model

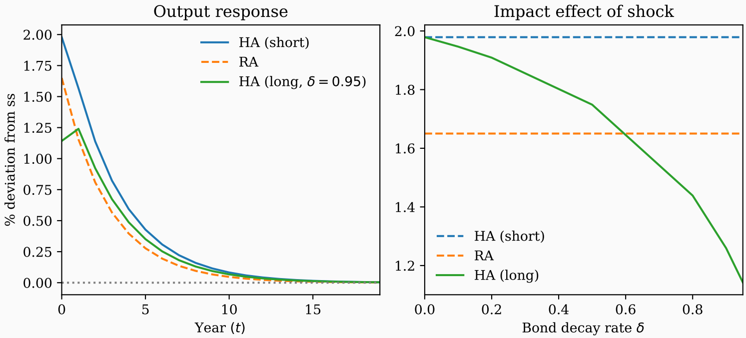
Our new DAG is:



Two new blocks:

- pricing: $q_t = \frac{1+\delta q_{t+1}}{1+r_t^{ante}}$ $\rightarrow$ can use a `SolvedBlock` here
- valuation: $r_t = \frac{1+\delta q_t}{q_{t-1}} - 1$

Impulse responses with longer maturities



- $\delta \uparrow \Rightarrow$ low MPC rich benefit from capital gains, while poor make losses [see also Auclert 2019]
- This reduces demand! HA < RA

Fiscal policy

So far, no fiscal side. But monetary-fiscal interactions potentially important!

$\rightarrow$ changes in r directly affect government budget!

Here: analyze consequences of fiscal response to monetary policy

For this, return to canonical model **with government bonds + linear taxation:**

$$\begin{aligned} V_t\left(a_-, e\right) &= \max u\left(c\right) + \beta \mathbb{E}\left[V_{t+1}\left(a, e'\right) | e\right] \\ c + a &= \left(1 + r_{t-1}^{ante}\right) a_- + \left(Y_t - T_t\right) e \\ a &\geq \underline{a} \end{aligned}$$

Setting up a fiscal rule

Calibration as in fiscal policy lecture. Government budget constraint:

$$(1 + r_{t-1}) B_{t-1} = T_t - G_t + B_t$$

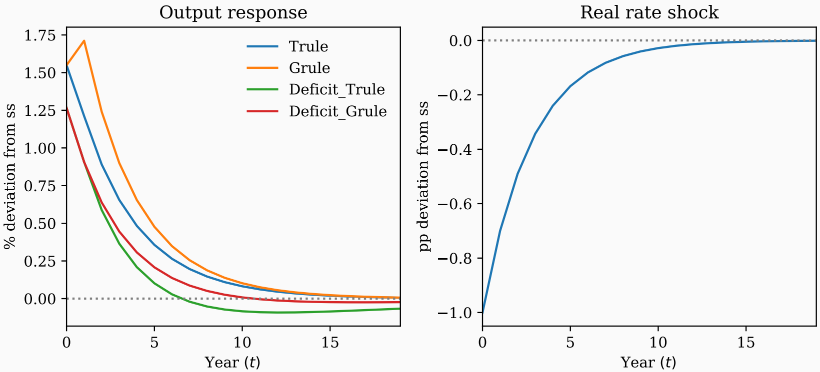
Consider following fiscal *rules*

1. Constant B, all regular taxes: $T_t = G + r_{t-1}B$
2. Constant B, all spending: $G_t = T - r_{t-1}B$
3. Deficit-finance, using taxes to bring debt back, $T_t = T + \phi_T (B_{t-1} - B)$
4. Deficit finance, using G spending to bring debt back $G_t = G - \phi_G (B_{t-1} - B)$

[Need $\phi_G, \phi_T > r$. Why?]

Note: these all correspond to different "fiscal blocks". With deficit finance, need `SolvedBlock`.

Importance of fiscal rule for AR(1) shocks to policy



- G rule has stronger effect on demand than T rule, both weaker with deficits
- With longer maturities, fiscal rule matters less Auclert et al. (2020)

Investment

Investment

No investment so far. Let's change this! [Reference: Auclert et al. (2020) appendix A]

$$C_t + I_t = Y_t = XK_t^{\alpha} N_t^{1-\alpha}$$

Obvious: output is affected differently now since investment responds

Not so obvious: does **consumption** respond differently?

Not true in RA model: C_t purely governed by Euler equation

$$C_t^{-\sigma} = \beta (1 + r_t) C_{t+1}^{-\sigma}$$

Same for given path of r_t! **What happens in HA?**

Model setup

Now final goods firm rents capital and labor, flexible prices,

$$w_t = X(1-\alpha) K_t^{\alpha} N_t^{-\alpha} \qquad r_t^K = X\alpha K_t^{\alpha-1} N_t^{1-\alpha}$$

Capital firm owns K_t and rents it out, invests s.t. quadratic costs, so

$$D_t = r_t^K K_t - I_t - \frac{\Psi}{2}\left(\frac{K_{t+1}-K_t}{K_t}\right)^2 K_t$$

- detour: Why adjustment costs? Without, **crazy elasticity of investment to** r_t

$$\frac{dK_{t+1}}{K} = -\frac{1}{1-\alpha}\frac{1}{r+\delta}dr_t \qquad \Rightarrow \qquad \frac{dI_0}{I} = -\frac{1}{1-\alpha}\frac{1}{r+\delta}\frac{1}{\delta}dr_0$$

with $\delta = 4\%$, $r = 1\%$, $\alpha = 0.3$, semi-elasticity is -715!

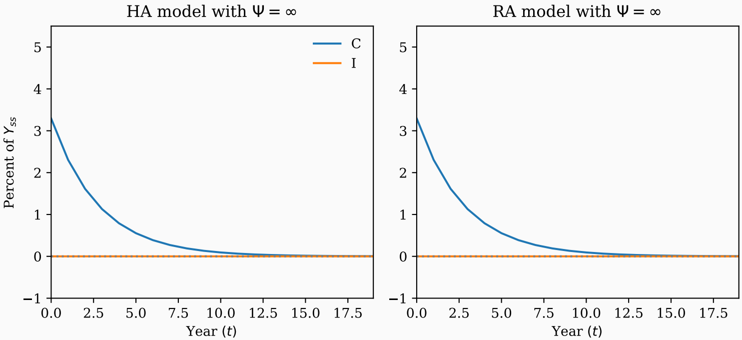
With quadratic adjustment cost, get Q theory equations, $\frac{I_t}{K_t} - \delta = \frac{1}{\Psi}(Q_t - 1)$ and

$$p_t = Q_t K_{t+1} = \frac{p_{t+1} + D_{t+1}}{p_t}$$

Neutrality result with inelastic investment

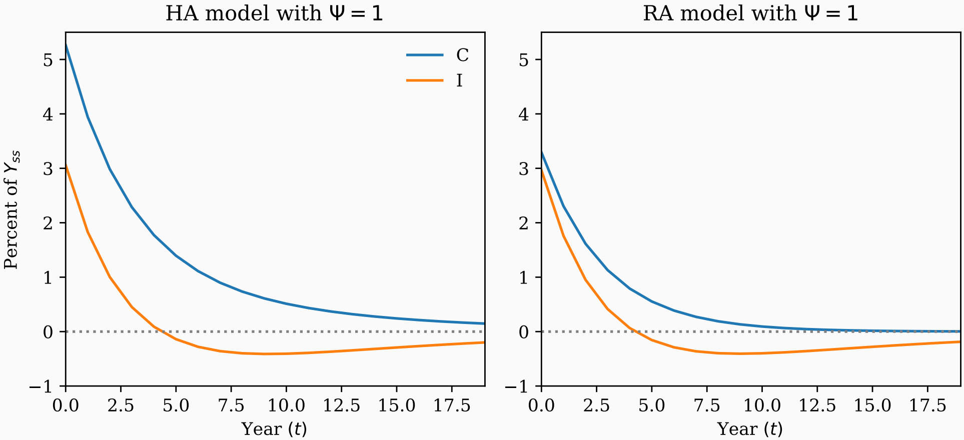
Neat result by Werning (2015): If investment does not respond $\Psi = \infty, \delta = 0$, but capital still there $\alpha > 0$, and EIS = 1 $\Rightarrow$ neutrality again, HA = RA!

Capital alone does not make a difference. Key: agents trade claims on capital whose price p_t gets revalued!



Elastic investment: HA>RA!

Auclert et al. (2020): elastic investment $\Psi < \infty \Rightarrow$ amplification! $I \to Y \to C$ link is key.



Nominal assets

Nominal assets

- So far, assets were all real. But many assets are nominal.
    - Again, think mortgage debt, nominal bonds, etc.
    - Creates very large exposures to inflation risk via nominal positions
    - See estimates in Doepke and Schneider (2006)
- Here: analyze consequence of one-period nominal assets.
- Assume that now:

$$P_t c_{it} + A_{it} = (1 + i_t) A_{it-1} + e_{it} W_t N_t$$
$$A_{it} \geq P_t \underline{a}$$

Note: nominal borrowing constraint relaxes with inflation.
In practice it's probably not so simple (eg "tilt effect" in mortgages)

Incorporating unexpected revaluation

- Define real asset position $a_{it} = A_{it}/P_t$. Household problem now

$$\begin{aligned} V_t(a_-, e) &= \max u(c) + \beta \mathbb{E}\left[V_{t+1}(a, e') \,|e\right] \\ c + a &= (1 + r_t) a_- + eY_t \\ a &\geq \underline{a} \end{aligned}$$

  where $1 + r_t = (1 + i_t) \frac{P_{t-1}}{P_t}$

- Perfect foresight Fisher equation gives again:

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

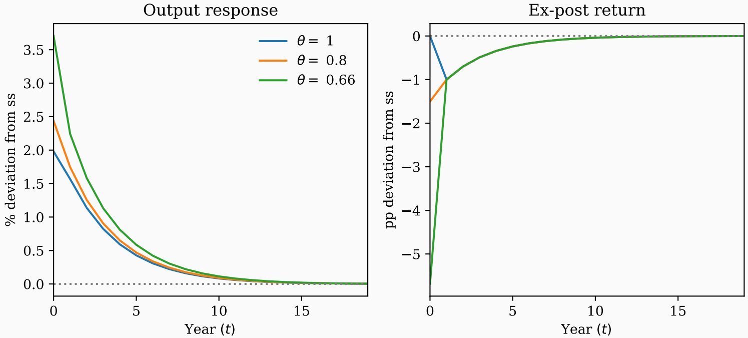
  but also "Fisher effect" (capital gain/loss) from date-0 revaluation

$$1 + r_0 = (1 + i_0) \frac{P_{-1}}{P_0} = (1 + r_{ss}) \frac{1 + \pi_{ss}}{1 + \pi_0}$$

- Even with r^{ante} rule, inflation now directly matters for demand via ex-post r_0

Aggregate implication of Fisher channel: AR(1) shock to r

- Again simple to simulate with SSJ (what is your DAG?)



- **Fisher effect**: inflation redistributes towards agents with lower nominal positions, who have high MPCs. Bigger with steeper Phillips curve (lower θ_w)
- Would be even more pronounced with long maturities

Takeaway

Conclusion

HANK substantially enriches the analysis of monetary policy.

Key points:

1. Indirect effects much larger than RA, though no robust result that HA $\gtrless$ RA
2. Countercyclical income risk has large amplification effects
3. Maturity structure & redistribution become important
4. Relevance of fiscal-monetary interactions (esp. with short maturities)
5. Complementarity between investment and high MPCs

The literature is growing and there is still a lot to do!

References

Acharya, S. and Dogra, K. (2020). Understanding HANK: Insights From a PRANK. *Econometrica*, 88(3):1113–1158.

Auclert, A. (2019). Monetary Policy and the Redistribution Channel. *American Economic Review*, 109(6):2333–2367.

Auclert, A. and Rognlie, M. (2018). Inequality and Aggregate Demand. Working Paper 24280, National Bureau of Economic Research,.

Auclert, A., Rognlie, M., and Straub, L. (2020). Micro Jumps, Macro Humps: Monetary Policy and Business Cycles in an Estimated HANK Model. Working Paper 26647, National Bureau of Economic Research,.

Bilbiie, F. O. (2021). Monetary Policy and Heterogeneity: An Analytical Framework. *Manuscript*.

Challe, E. (2020). Uninsured Unemployment Risk and Optimal Monetary Policy in a Zero-Liquidity Economy. *American Economic Journal: Macroeconomics*, 12(2):241–283.

den Haan, W. J., Rendahl, P., and Riegler, M. (2018). Unemployment (Fears) and Deflationary Spirals. *Journal of the European Economic Association*, Forthcoming.

Doepke, M. and Schneider, M. (2006). Inflation and the Redistribution of Nominal Wealth. *Journal of Political Economy*, 114(6):1069–1097.

Guvenen, F., Ozkan, S., and Song, J. (2014). The Nature of Countercyclical Income Risk. *Journal of Political Economy*, 122(3):621–660.

McKay, A., Nakamura, E., and Steinsson, J. (2016). The Power of Forward Guidance Revisited. *American Economic Review*, 106(10):3133–3158.

Ravn, M. O. and Sterk, V. (2017). Job Uncertainty and Deep Recessions. *Journal of Monetary Economics*, 90(Supplement C):125–141.

Storesletten, K., Telmer, C. I., and Yaron, A. (2004). Cyclical Dynamics in Idiosyncratic Labor Market Risk. *Journal of Political Economy*, 112(3):695–717.

Werning, I. (2015). Incomplete Markets and Aggregate Demand. Working Paper 21448, National Bureau of Economic Research,.