Monetary policy topics

Heterogeneous-Agent Macro Workshop

Spring 2022

Today

This morning: We 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. Maturity structure
2. Nominal assets
3. Fiscal policy
4. Investment
5. Taylor rules
6. Takeaway

Maturity structure

Longer maturities

- So far, model had short maturities. In practice, maturities are long.
    - Think mortgage debt, bonds, etc.
- What are the implications of long maturities for monetary policy?
- First study real assets. For tractability, adopt Calvo bonds.
    - Buy one bond today for q_t, get stream of real payments $1, \delta, \delta^2, \cdots$
- 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 λ is total number of bonds (total current coupon)

- Pricing equation (no arbitrage): $q_t = \frac{1+\delta q_{t+1}}{1+r_t^{ante}}$

Steady state

- In steady state $1 + \delta q = (1 + r)\, q$. Can redefine $a \equiv q\lambda$
  - Given $\underline{a}$, r, β, steady state is exactly identical to before! Intuition?
- New useful statistic from steady state: bond duration

$$D = \frac{1}{1+r} \sum_{s \geq 0} s \left(\frac{\delta}{1+r} \right)^s = \frac{1}{1+r} \left(\frac{1}{1 - \frac{\delta}{1+r}} \right)^2 = \frac{1+r}{1+r-\delta}$$

- Use this result to map empirical duration D into model δ
  - eg $D = 18$ quarters in U.S. Doepke and Schneider (2006)

- Relabel $a_{it} \equiv q_t \lambda_{it}$, then for any $t \geq 1$, we can rewrite the Bellman as

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

- What happens at $t = 0$? A revaluation:

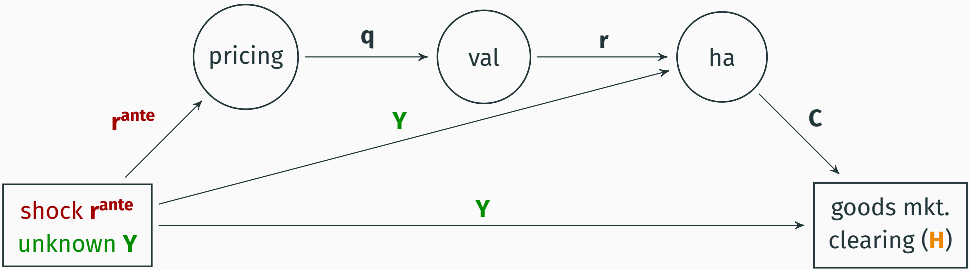
$$1 + r_0 = \left(1 + r_{ss}\right) \frac{1 + \delta q_0}{1 + \delta q_{ss}} = \frac{1 + \delta q_0}{q_{ss}} \tag{1}$$

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

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

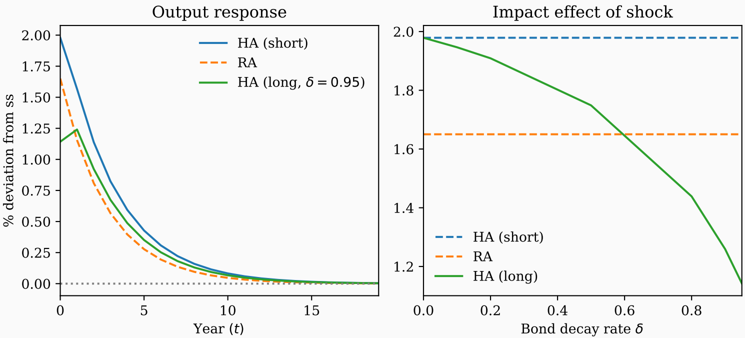
DAG for the long-bonds model

Our new DAG is:



Not so different from before! Just use a `SolvedBlock` to get the q first!

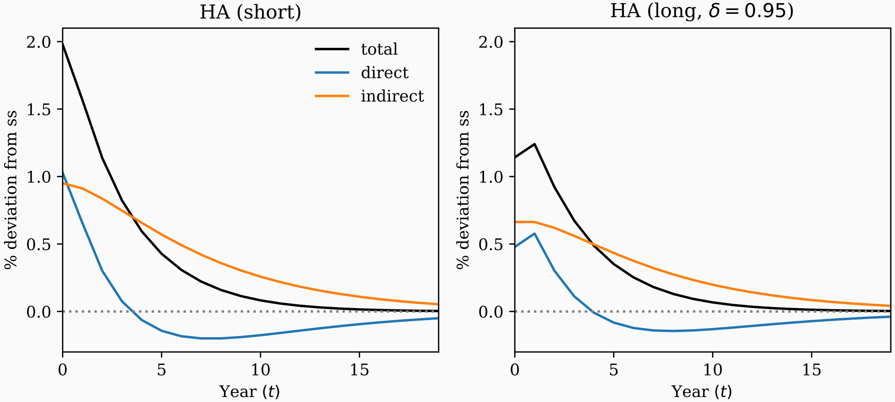
Impulse responses with longer maturities



- $\delta \uparrow$: more even distribution of s.s. "interest rate exposures" Auclert (2019)
- Intuition: low MPC rich get more capital gains, poor make capital losses
- This effect is enough to get us to other side of RA!

Decomposition into direct and indirect effects

- These income effects show up as lower direct effects in our decomposition



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

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

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

- Perfect foresight Fisher equation gives again:

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

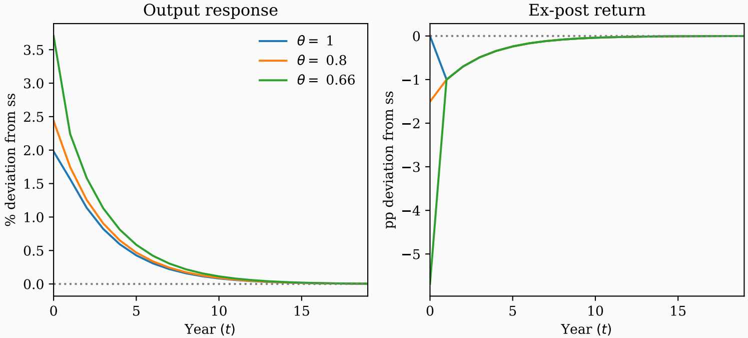
  but also "Fisher effect" (capital gain/loss) from date-0 revaluation

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

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

Fiscal policy

- So far, abstracted from fiscal policy. But monetary-fiscal interactions potentially very important!
    - Changes in r directly affect government budget
- Here: analyze consequences of fiscal response to monetary policy
- Go back to canonical model with government and linear taxation:

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

where $\tau_t(e)$ can be used to vary the tax incidence of shocks to mon. policy.

Setting up a fiscal rule

- Calibration as in lecture 4, with $\tau(e) = 0$ in steady state
- Government budget constraint:

$$B_t = (1 + r_{t-1}) B_{t-1} + G_t - T_t + \mathbb{E}[\tau_t(e)]$$

  and in steady state, $\mathbb{E}[\tau(e)] = 0$ and $T = G + rB$.

- 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?

  Alternative: tax one type only, $\tau_t(e) = \tau_t 1_{e=\bar{e}}$

Implications of deficit rules

- For instance with G rule, deficits follow

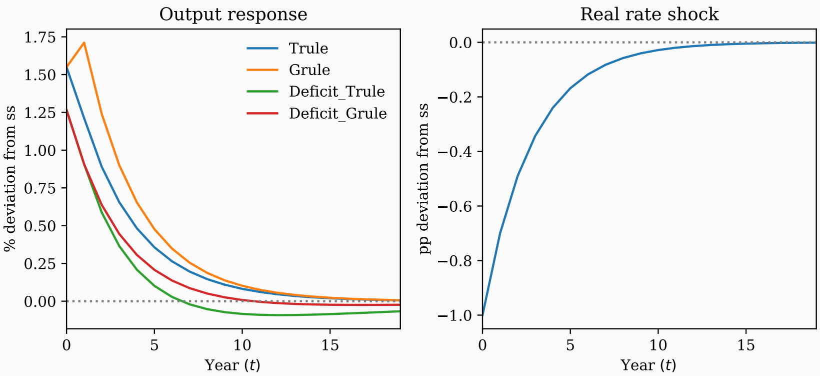
$$B_t - B = (1 - (\phi_G - r))(B_{t-1} - B) + (r_{t-1} - r) B_{t-1}$$

  To first order around the steady state (recall $\phi_G > r$),

$$\begin{aligned} dB_t &= (1 - (\phi_G - r)) dB_{t-1} + dr_{t-1} B \\ &= \sum_{k=0}^{t-1} (1 - (\phi_G - r))^k B dr_{t-1-k} \end{aligned}$$

  Past effect of high interest rates cumulate into current debt
- To set this up in code, again we'll use a `SolvedBlock`
  - recall that takes in a function $\mathbf{H}(\mathbf{U}, \mathbf{Z}) = 0$ and turns it into a mapping $\mathbf{U}(\mathbf{Z})$
  - Here, we get $\mathbf{B}(\mathbf{r})$ so $\mathbf{T}(\mathbf{r})$ and $\mathbf{G}(\mathbf{r})$.

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



- Ordering of output respond corresponds to that of fiscal effect on demand
- With longer maturities, fiscal rule matters less Auclert et al. (2020)

Investment

Investment

- So far, model only featured consumption
  - But empirically, investment is a key component of response to mon. policy!
- Here: introduce investment. 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: purely governed by Euler equation

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

What about in HA?

- As in any model with nom. rigidities and I_t, we *need* adjustment costs. Why?
- Without, firm optimality implies $\alpha X\left(K_{t+1}/N_{t+1}\right)^{\alpha-1}=r_t+\delta$, so given N,

$$\frac{dK_{t+1}}{K}=\frac{-1}{1-\alpha}\frac{1}{r+\delta}dr_t$$

  and since $I_t=K_{t+1}-(1-\delta)K_t$, initial I response is

$$\frac{dI_0}{I}=\frac{-1}{1-\alpha}\frac{1}{r+\delta}\frac{1}{\delta}dr_0$$

  Ex: with $\delta=4\%$, $r=1\%$, $\alpha=0.3$, semielasticity is -715!!
  - ie, 1% decline in r leads to a 715% increase in I on impact
- This is really important for all models of monetary policy with investment. Neoclassical effect that is there even in models with fixed costs, etc.
- Usual solution: convex adjustment costs (e.g. quadratic)

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

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

- Delivers standard Q theory equations, $\frac{I_t}{K_t} - \delta = \frac{1}{\Psi}(Q_t - 1)$ and

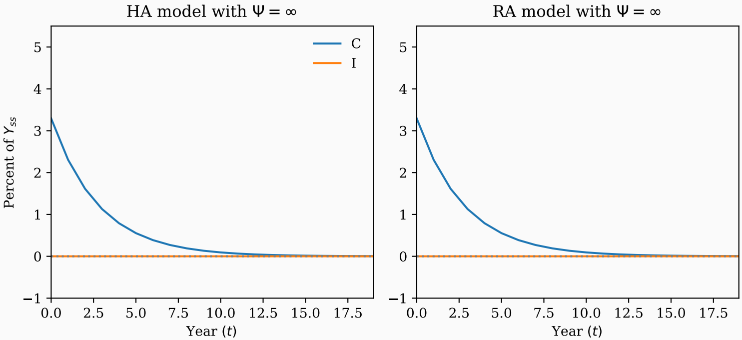
$$p_t = Q_t K_{t+1} = \frac{p_{t+1} + D_{t+1}}{p_t}$$

- GE asset market clearing:

$$A_t = p_t$$

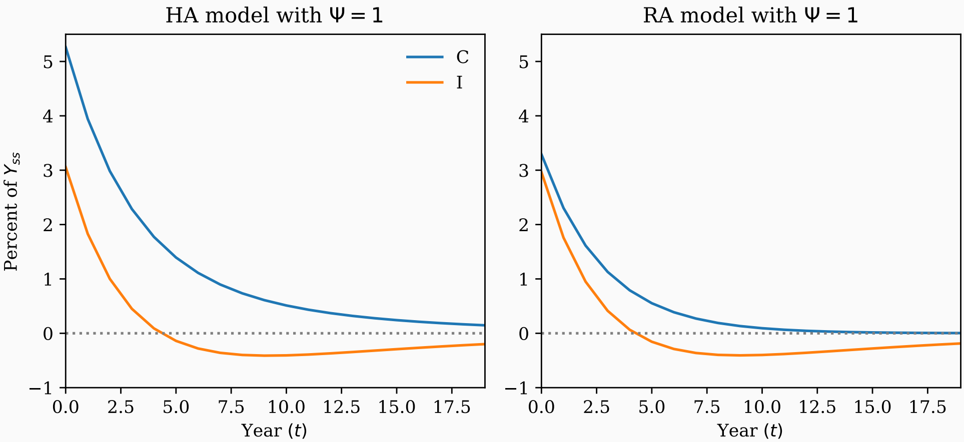
Neutrality result with inelastic investment

- Suppose that investment inelastic is $\Psi = \infty$, $\delta = 0$ (fixed K), and EIS=1.
- **Result**: neutrality (HA=RA). Why? Everyone affected in proportion. No redistribution between or across workers and capitalists.
- Version of Werning (2015), with positive liquidity and $\sigma = 1$.



Elastic investment: HA>RA!

- Now consider elastic investment $\Psi < \infty$: amplification!!



- For the *consumption* response to *r* shock:

	RA	HA
no I	Benchmark	Same (Werning)
with *I*	Same (Euler eq.)	**Amplification**

- This is one direct reason why we should care that MPCs are large!

Taylor rules

Taylor rule

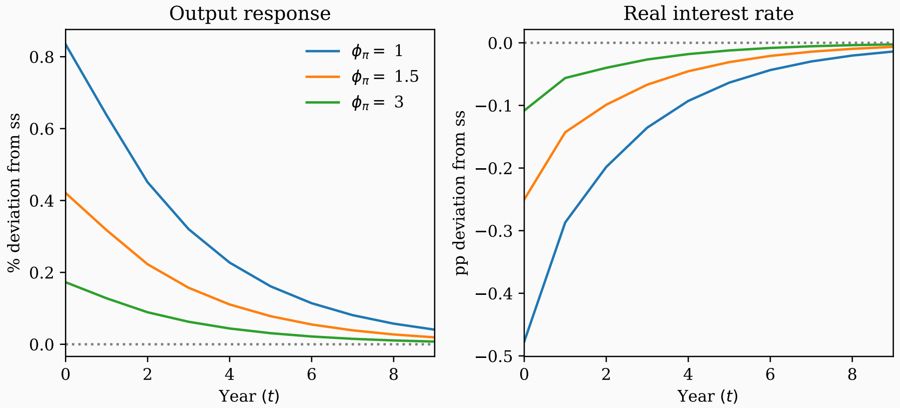
- So far, all monetary policy analyzed using r rule.
  - In practice, Taylor rule intermediates response to many shocks
  - Here, study shocks to TFP X_t in addition to monetary ϵ_t
- Since real rate is

$$r_t = i_t - \pi_{t+1} + \epsilon_t = i + \phi_\pi \pi_t - \pi_{t+1} + \epsilon_t$$

  We now set up the DAG with π as an unknown

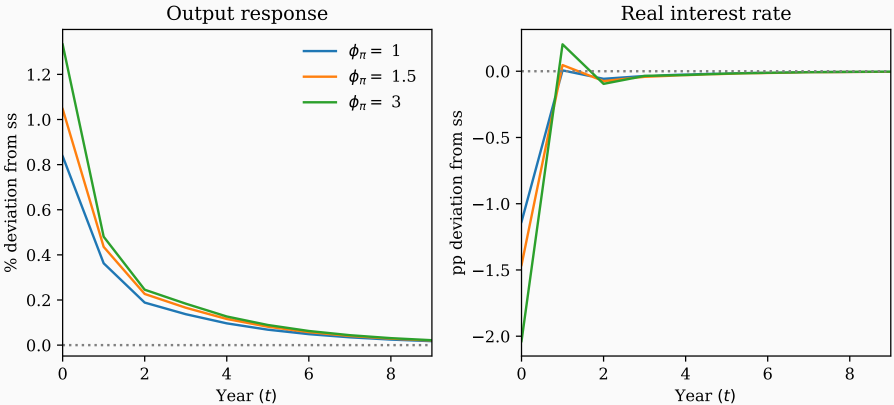
- This model has all the basic elements one needs for estimation
  - See tomorrow's lecture!!

Response to AR(1) monetary shock



- Endogenous tightening to inflation mitigates r_t drop for given ϵ_t

Response to AR(1) TFP shocks



- Deflationary effect of TFP shock leads to *r* cut, so boost in demand

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. Importance of maturity structure and nominal asset positions
  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

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