Monetary policy topics

NBER Heterogeneous-Agent Macro Workshop

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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. Maturity structure
2. Nominal assets
3. Fiscal policy
4. Investment
5. Takeaway
Maturity structure
Longer maturities

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:

$$V_t(\lambda, e) = \max u(c) + \beta \mathbb{E} [V_{t+1}(\lambda, e') | e]$$

$$c + q_t \lambda = (1 + \delta q_t) \lambda - e Y_t$$

$$q_t \lambda \geq a$$

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

\[ c + q\lambda = (1 + r) q\lambda - eY \]
\[ q\lambda \geq a \]

Redefining \( a \equiv q\lambda \) means steady state is identical given \( a, r, \beta \).

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

What about date \( t = 0 \)? \textbf{Revaluation effect!}

\[ 1 + r_o = (1 + r_{ss}) \frac{1 + \delta q_o}{1 + \delta q_{ss}} = \frac{1 + \delta q_o}{q_{ss}} \neq 1 + r_{o ante} \quad (1) \]

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: \( q_t = \frac{1+\delta q_{t+1}}{1+r_{t}^{\text{ante}}} \) → 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
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:

\[ P_t c_{it} + A_{it} = (1 + i_t) A_{it-1} + e_{it} W_t N_t \]

\[ A_{it} \geq P_t a \]

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

$$V_t (a_-, e) = \max u (c) + \beta \mathbb{E} [V_{t+1} (a', e') | e]$$

$$c + a = (1 + r_t) a_- + eY_t$$

$$a \geq a$$

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-o revaluation

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

- Even with $r^{ante}$ rule, inflation now directly matters for demand via ex-post $r_o$
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 $\theta_w$)
- Would be even more pronounced with long maturities
Fiscal policy
Fiscal-monetary interactions

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

→ 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:

$$V_t (a_, e) = \max u (c) + \beta \mathbb{E} [V_{t+1} (a, e') | e]$$

$$c + a = (1 + r^{ante}_{t-1}) a_ - + (Y_t - T_t) e$$

$$a \geq \underline{a}$$
Setting up a fiscal rule

Calibration as in fiscal policy lecture. Government budget constraint:

\[(1 + r_{t-1}^{ante}) B_{t-1} = T_t - G_t + B_t\]

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 financing, 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 \textit{Auclert et al. (2020)}
Investment
No investment so far. Let’s change this!  

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

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

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

Same for given path of $r_t^{ante}$! What happens in HA?
Model setup

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

$$w_t = X (1 - \alpha) K_t^\alpha N_t^{1-\alpha} \quad r^K_t = X \alpha K_t^{\alpha-1} N_t^{1-\alpha}$$

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

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

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

$$\frac{dK_{t+1}}{K} = -\frac{1}{1 - \alpha} \frac{1}{r + \delta} dr_t \quad \Rightarrow \quad \frac{dl_0}{l} = -\frac{1}{1 - \alpha} \frac{1}{r + \delta} \frac{1}{\delta} dr_0$$

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

With quadratic adjustment cost, get Q theory equations, $\frac{l_t}{K_t} - \delta = \frac{1}{\psi} (Q_t - 1)$ 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!

![Graph](image1.png)
Elastic investment: HA>RA!

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

**Graphs:**
- **HA model with $\Psi = 1$:**
  - Graph showing percent of $Y_{ss}$ over years for the HA model.
  - **C** and **I** lines are depicted.
- **RA model with $\Psi = 1$:**
  - Graph showing percent of $Y_{ss}$ over years for the RA model.
  - **C** and **I** lines are depicted.
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 ≥ 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

