Monetary Policy According to HANK

ANU RSE Macro Study Group, Feb 17, 2021

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Questions/Motivation

- Holy grail questions:
  - *What constitute* the (conventional, r) *monetary policy* (MP) *transmission mechanism*?
  - How *big* are they?
  - What dominates what—i.e., what is net effect of mechanism?
- Purpose:
  - Accurate accounting of components crucial for "successful" conduct of monetary policy
- This paper:
  - Focus on household *consumption* demand channel(s): direct vs indirect effects

Empirical evidence

- Macro evidence:
  - consumption not so sensitive to changes in interest, controlling for income
- Micro (SCF) evidence:
  - 25-33% of households have close to **zero** liquid wealth (e.g., bank balances) and face high borrowing costs
    $\Rightarrow$ high *individual* MPCs, low interest sensitivity
    (depends on h/hold balance sheet composition of liquid/illiquid assets)
  - *aggregated* quarterly MPC of about 0.25
- A *causal question* needing a causal structure:
  - Focus on household *consumption* demand channel(s): direct vs indirect effects

Model taxonomy

- **R**epresentative **A**gent **N**ew **K**eynesian
  - Sticky nominal price (Rotemberg) + Permanent-income consumer
- **H**eterogeneous **A**gent **N**ew **K**eynesian ... *Por que no tres*?
  - Sticky nominal price (Rotemberg)
  - Uninsurable idiosyncratic income risk (Bewley $\twoheadrightarrow$ Huggett/Aiyari/İmhoroğlu)
    - Borrowing constraints
    - Incomplete asset market(s)
  - Multiple assets with liquidity premia (Kaplan-Violante)
    - Costly portfolio rebalancing

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- Uninsurable idiosyncratic income risk + Asset classes deliver:
  - large fraction of poor *and* wealthy hand-to-mouth (HTM) consumers
    - these agents have high MPCs, low interest sensitivities
    - c.f. permanent-income-hypothesis (PIH) consumer
- If monetary policy widens spread in asset returns, agents rebalance portfolios towards high-yield asset
- Macro 2 lessons:
  - Kinked individual budget constraints break Ricardian equivalence
  - Room for fiscal policy (FP) influence in GE

Forces at work (calibrated models)

Partial equilibrium decompositions:

- Focus on household **consumption** demand channel(s)

$$\text{Direct}(\Delta r) + \text{Indirect}(\Delta Y) \longrightarrow \Delta C$$

  - **Direct:** intertemporal substitution effects
  - **Indirect:** Income effects
- **RANK** (direct $\sim 99\%$, indirect $\sim 1\%$)
- **HANK** (direct $< 20\%$, indirect $> 80\%$)

General equilibrium overall effect?

- **RANK** independent of FP (Ricardian equivalence)
- **HANK** FP also matters for C (non-Ricardian) and for slope of Phillips curve (PC).

Monetary transmission

Implications:

- **RANK** — just focus on directly influencing r and let intertemporal substitution "do the work" (Euler-IS curve)
  - small, persistent or large, transient MP cuts are the same if cumulative cut is equal.
- **HANK** — size, composition and timing of policy matters.
  - transient but large MP cuts more effective in boosting C
  - passive (debt as shock absorber) FP provides PC tradeoff that is friendlier to MP.

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Section I:

- RANK in continuous time (Werning, 2015)
- Consider extreme case of fixed prices—MP as if controlling real r_t
- Suffices to focus on Euler-IS equation:

$$\frac{\dot{C}_t}{C_t} = \frac{1}{\gamma}(r_t - \rho)$$

and a time-path for MP:

$$r_t = \rho + e^{-\eta t}(r_0 - \rho), \qquad t \geq 0.$$

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Proposition 1

- Direct (r_t) and indirect (Y_t) effects on C are linearly decomposable

$$d \log C_0 = -\frac{1}{\gamma}\int_0^\infty e^{-\rho t} dr_t dt - \frac{\rho}{\gamma}\int_t^\infty dr_s ds dt$$

- Simplifies to

$$\frac{d \log C_0}{dr_0} = \frac{1}{\gamma\eta}\left(\underbrace{\frac{\eta}{\rho+\eta}}_{\text{direct, } r} + \underbrace{\frac{\rho}{\rho+\eta}}_{\text{indirect, } Y}\right)$$

  - More risk averse (higher γ), smaller response.

RANK to TANK

More general setups ...

- If government debt is nonzero, so exists tax sequence T_t to balance intertemporal GBC. Even so, decomposition

$$\frac{d\log C_0}{dr_0} = \frac{1}{\gamma\eta}\left[\underbrace{\frac{\eta}{\rho+\eta}\left(1-\rho\gamma\frac{B_0}{\bar{Y}}\right)}_{\text{direct, } r} + \underbrace{\frac{\rho}{\rho+\eta}}_{\text{indirect, } Y} + \underbrace{\frac{\eta}{\rho+\eta}\left(\rho\gamma\frac{B_0}{\bar{Y}}\right)}_{\text{indirect, } T}\right]$$

  largely driven by direct channel (for plausible debt-to-GDP ratios).
- **TANK**: Ad-hoc share of rule-of-thumb or hand-to-mouth consumers? Similar conclusion.
- How about even more detail? Table 1, p708.

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Aggregate supply - Rotemberg's NKPC

Rotemberg's NKPC:

$$\pi_t = \underbrace{\frac{1}{\left(r_t^a - \frac{\dot{Y}}{Y}\right)}}_{\text{discounting}} \left[\underbrace{\dot{\pi}_t}_{\text{Future inflation}} + \frac{\varepsilon}{\theta} \underbrace{(m_t - m^*)}_{\text{real MC dev.}} \right],$$

- $1/m^* = \varepsilon/(\varepsilon - 1)$ Ramsey optimal, flex-price monopolistic markup
- $m_t = \left(\frac{r_t^k}{\alpha}\right)^{\alpha} \left(\frac{w_t}{1-\alpha}\right)^{1-\alpha}$ real marginal cost of production

π_t s.t. marginal cost of instantaneous price change $=$ PV of future price-change marginal profits:

$$\theta \pi_t Y_t = \varepsilon \int_t^{\infty} e^{-\int_t^s r_\tau^a d\tau} Y_s (m_s - m^*) ds$$

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Heterogeneous demand - Bewley households

Preference representation:

$$\mathbb{E}_0 \int_0^\infty e^{(\rho+\zeta)t} u(c_t, \ell_t) dt$$

- ζ Poisson death rate (intensity)
- Controls: c, ℓ, a, b, d

Constraints on liquid (b) and illiquid (a) asset demands,

$$\dot{b}_t = (1-\tau_t) w_t z_t \ell_t + r_t^b(b_t) b_t + T_t - d_t - \chi(d_t, a_t) - c_t$$
$$\dot{a}_t = r_t^a a_t + d_t$$
$$b_t \geq -\underline{b}, \qquad , a_t \geq 0$$

Costly portfolio adjustment (d):

$$\chi(d,a) = \chi_0 \left|d\right| + \chi_1 \left|\frac{d}{a}\right|^{\chi_2} a,$$

- V-shaped part: implies states where agents would optimally do nothing
- Convex part: never optimal to withdraw/deposit infinite quantities

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Policy makers

Monetary authority:

- (Henderson-McKibbin-)Taylor rule:

$$i_t = \bar{r}^b + \phi\pi_t + \epsilon_t, \qquad \phi > 1$$

- Return on government bonds (Fisher relation):

$$r_t^b = i_t - \pi_t$$

Fiscal authority:

- Exogenous G_t, imposes taxes $(\tau_t, T_t) > 0$ issues liquid bonds B_t^g (assumed to be a consol) s.t.

$$\dot{B}_t + G_t + T_t = \tau_t \int w_t z \ell_t(a, b, z) du_t + r_t^b B_t^g$$

HANK - Stationary Equilibrium

Individual household's asset balance sheet

Share price q, PV of firm profits Π, equity s, capital k

- Illiquid asset/claims:

$$a_t = k_t + q_t s_t$$

- Portfolio dynamics:

$$\dot{k}_t + q_t \dot{s}_t = (r_t^k - \delta)k_t + \Pi_t s_t + d_t$$

  where $r_t^k - \delta = r_t^a$.

- No-arbitrage: returns on equity and capital must equalize

$$\frac{\Pi_t - \dot{q}_t}{q_t} = r_t^a$$

HANK - Stationary Equilibrium

Market clearing

- Liquid asset—total household bonds equals outstanding government debt

$$\int b d\mu_t = -B_t^g$$

- Illiquid asset

$$\int a d\mu_t = K_t + q_t \cdot 1$$

  Dixit-Stiglitz firms live on $[0,1]$.

- Labor:

$$\int z\ell_t(a,b,z) d\mu_t = N_t$$

- Goods

$$Y_t = C_t + I_t + G_t + \Theta_t + \chi_t + \kappa \int \max\left\{-b, 0\right\} d\mu_t$$

Lesson 1

Monetary transmission

Decomposing initial consumption response:

$$dC_0 = \underbrace{\int_0^\infty \frac{\partial C_0}{\partial r_t^b} dr_t^b dt}_{\text{direct}} + \underbrace{\int_0^\infty \left(\frac{\partial C_0}{\partial w_t} dw_t + \frac{\partial C_0}{\partial r_t^a} dr_t^a + \frac{\partial C_0}{\partial \tau_t} d\tau_t + \frac{\partial C_0}{\partial T_t} dT_t \right) dt}_{\text{indirect}}$$

- Direct: Intertemporal (as in RANK's total effect) + income effects (wealth no long in zero supply plus hetero wealth)
- Indirect: First two would be standard income effect. Latter two is new! Fiscal policy channel (non-Ricardian h/holds)

Decomposition by numerical simulation:

- See Table 7 under calibrated model and alternative scenarios.
- Insight: Indirect effects (w and T) $> 80\%$

Lesson 2

Why indirect effects dominate?

$$dC_0 = \underbrace{\int_0^\infty \frac{\partial C_0}{\partial r_t^b} dr_t^b dt}_{\text{direct}} + \underbrace{\int_0^\infty \left(\frac{\partial C_0}{\partial w_t} dw_t + \frac{\partial C_0}{\partial r_t^a} dr_t^a + \frac{\partial C_0}{\partial \tau_t} d\tau_t + \frac{\partial C_0}{\partial T_t} dT_t \right) dt}_{\text{indirect}}$$

Largely due to wealth redistribution effects

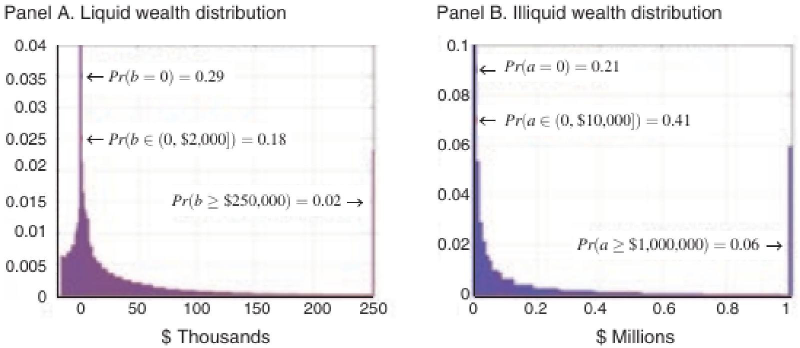

FIGURE 1. DISTRIBUTIONS OF LIQUID AND ILLIQUID WEALTH

Lesson 2

Why indirect effects dominate?

$$dC_0 = \underbrace{\int_0^\infty \frac{\partial C_0}{\partial r_t^b} dr_t^b dt}_{\text{direct}} + \underbrace{\int_0^\infty \left(\frac{\partial C_0}{\partial w_t} dw_t + \frac{\partial C_0}{\partial r_t^a} dr_t^a + \frac{\partial C_0}{\partial \tau_t} d\tau_t + \frac{\partial C_0}{\partial T_t} dT_t \right) dt}_{\text{indirect}}$$

Wealth effects — fix your stare around $b = 0$!

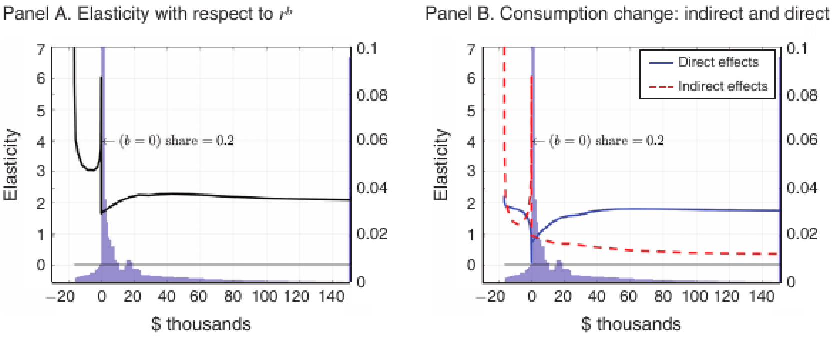

Figure 5. Consumption Responses by Liquid Wealth Position

Lesson 2

Why indirect effects dominate?

$$dC_0 = \underbrace{\int_0^\infty \frac{\partial C_0}{\partial r_t^b} dr_t^b dt}_{\text{direct}} + \underbrace{\int_0^\infty \left(\frac{\partial C_0}{\partial w_t} dw_t + \frac{\partial C_0}{\partial r_t^a} dr_t^a + \frac{\partial C_0}{\partial \tau_t} d\tau_t + \frac{\partial C_0}{\partial T_t} dT_t \right) dt}_{\text{indirect}}$$

Wealth effects (decomposed)— fix your stare around $b = 0$!

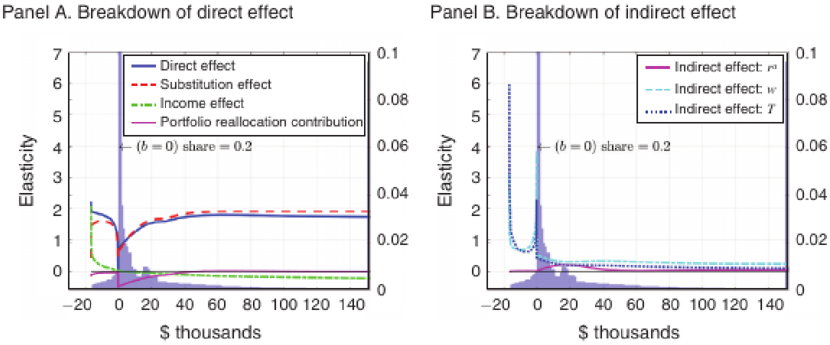

FIGURE 6. CONSUMPTION RESPONSES BY LIQUID WEALTH POSITION

Lesson 2

Why indirect effects dominate?

$$dC_0 = \underbrace{\int_0^\infty \frac{\partial C_0}{\partial r_t^b} dr_t^b dt}_{\text{direct}} + \underbrace{\int_0^\infty \left(\frac{\partial C_0}{\partial w_t} dw_t + \frac{\partial C_0}{\partial r_t^a} dr_t^a + \frac{\partial C_0}{\partial \tau_t} d\tau_t + \frac{\partial C_0}{\partial T_t} dT_t \right) dt}_{\text{indirect}}$$

Wealth effects (decomposed)— fix your stare around $b = 0$!

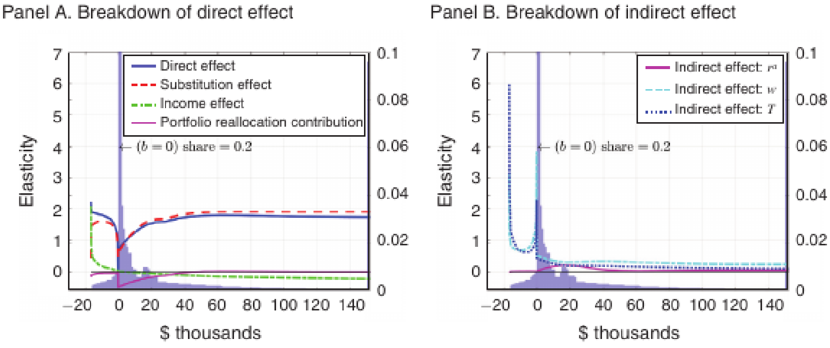

Figure 6. Consumption Responses by Liquid Wealth Position

Lesson 3

Fiscal policy matters for MP conduct

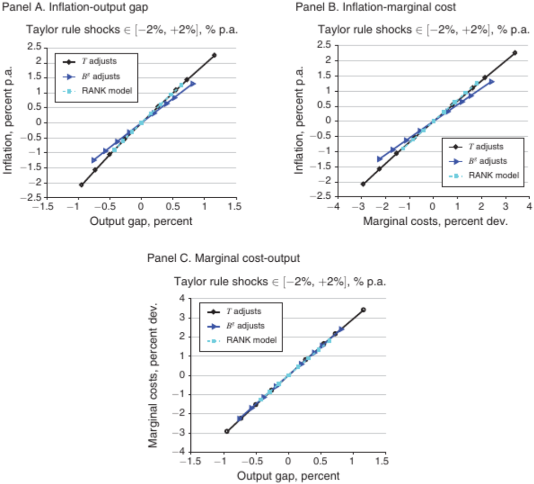

Figure 9. Analysis of Inflation-Activity Trade-Off

Reflections

- Good example of careful model setup, clear exposition of economic mechanism and connections to micro data on consumption/MPC distribution
- Model inherits from two textbook models we are familiar with plus a more recent quantitative hack:
  - NK sticky price
  - Bewley exogenously incomplete markets
  - costly portfolio rebalancing
- Interesting twist to insight of "standard" macro-MP model: Heterogeneity, MP and FP coordination matters
  - Wealth effects matter much more than just the aggregate IS curve

Reflections

- Questions/comments
  - If identifying possible channels of MP transmission is important, why stop at black-box descriptions of financial markets: $\chi(\cdot)$, $\underline{b}$?
  - Model has sticky prices but no price dispersion. What if we have both endogenously—not by assumption of menu cost $\Theta(\cdot)$?
- What if these "mechanical devices" also depend on policy? Would we get even more surprising insights? Or are they of higher (lesser) order of importance?
- What is a "standard" model? Do we remain in close orbit around what is effectively a neoclassical planet?

Stationary equilibrium as PDE

Consider a stripped down version of HANK into its Bewley-Huggett component:

$$\max_c \left\{ \begin{array}{lc} \mathbb{E}_0 \int_0^\infty e^{-\rho t} u(c_t) dt : & \\ & \dot{a}_t = z_t + r_t a_t - c_t \\ & \dot{z}_t = \mu(z_t) dt + \sigma(z_t) dW_t \\ & a_t \geq \underline{a} \end{array} \right\}$$

Equilibrium must satisfy market clearing

$$\int a g_t(a,z) da dz = 0$$

(Achdou *et al*, 2014, Phil. Trans. R. Soc. A)

Stationary equilibrium as PDE

A *dynamic* *(stationary) equilibrium* is pair of time-dependent (independent) value and density functions $(a, z) \mapsto (v, g)(a, z)$ and a real rate r solving:

$$\partial_t v + \frac{1}{2}\sigma^2(z)\partial_{zz}v + \mu(z)\partial_z v + (z + r(t)a)\partial_a v + H(\partial_a v) - \rho v = 0 \tag{1}$$

$$\partial_t g - \frac{1}{2}\partial_{zz}\left[\sigma^2(z)g\right] + \partial_z\left[\mu(z)g\right] + \partial_a\left[(z + r(t)a)g\right] + \partial_a\left[\partial_p H\left(\partial_a v\right)g\right] = 0 \tag{2}$$

$$\int ag(a, z, t)dadz = 0 \tag{3}$$

$$\int g(a, z, t)dadz = 1, g \geq 0 \tag{4}$$

where $H(p) = \max_{c \geq 0}\{-pc + u(c)\}$ and some boundary value conditions.

1. $v \leftarrow$ Hamilton-Bellman-Jacobi equation
2. $g \leftarrow$ Fokker plank equation s.t. (3) and (4)

Solution

- Time-dependent solution on $(\underline{a}, \infty) \times (\underline{z}, \overline{z}) \times (0, T)$ and imposes $T \to 0$, and $v\,(a, z, T) = v_\infty(a, z)$.
- In practice, solution is done using a finite-difference method ("upwind").
- In theory, there are some sticking points:
  - Stationary equilbrium of this coupled PDE: uniqueness unknown.
  - Dynamic equilbrium of this coupled PDE: existence and uniqueness unknown.