Monetary Policy According to HANK

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ECB Conference on Household Finance and Consumption
HANK: Heterogeneous Agent New Keynesian models

• Framework for quantitative analysis of aggregate fluctuations and macroeconomic policy

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HANK: Heterogeneous Agent New Keynesian models

- Framework for quantitative analysis of aggregate fluctuations and macroeconomic policy

- Two building blocks
  1. Rich representation of *hh finances and consumption* behavior
  2. Nominal price rigidities

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HANK: Heterogeneous Agent New Keynesian models

- Framework for quantitative analysis of aggregate fluctuations and macroeconomic policy

- Two building blocks
  1. Rich representation of hh finances and consumption behavior
  2. Nominal price rigidities

- Today: Transmission mechanism for conventional monetary policy

- Main result: Stark difference between HANK and \( \text{RANK} \)
Monetary transmission in RANK and HANK

\[ dC = \frac{\partial C}{\partial r} dr + \frac{\partial C}{\partial Y} dY \]

direct response to \( r \) \hspace{1cm} indirect GE response due to \( Y \)
Monetary transmission in RANK and HANK

\[ dC = \frac{\partial C}{\partial r} dr + \frac{\partial C}{\partial Y} dY \]

direct response to \( r \) \hspace{2cm} indirect response due to \( Y \)

**RANK:** >95% \hspace{2cm} **RANK:** <5%

**HANK:** <25% \hspace{2cm} **HANK:** >75%

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Monetary transmission in RANK and HANK

\[ dC' = \frac{\partial C'}{\partial r} dr + \frac{\partial C'}{\partial Y} dY \]

direct response to \( r \)       indirect response due to \( Y \)

- **RANK**: >95%                   - **RANK**: <5%
- **HANK**: <25%                   - **HANK**: >75%

**RANK view:**

- MPC out of \( r \) strong b/c of intertemporal substitution
- MPC out of \( Y \) weak b/c the RA is a PIH consumer
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- **HANK view:**
  - MPC out of \( r \) weak b/c several effects offset int. substitution
  - MPC out of \( Y \) strong b/c of sizable share of HtM households
Why does this difference matter?

- Suppose Fed wants to stimulate $C$

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  - sufficient to influence the real rate $\{r_t\}$
  - household intertemporal substitution does the rest
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- HANK view:
  - must rely heavily on GE transmission to aggr. labor demand
  - through fiscal policy reaction or an investment boom
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• Suppose Fed wants to stimulate $C$

• RANK view:
  ▶ sufficient to influence the real rate $\{r_t\}$
  ▶ household intertemporal substitution does the rest

• HANK view:
  ▶ must rely heavily on GE transmission to aggr. labor demand
  ▶ through fiscal policy reaction or an investment boom
  ▶ Responsiveness of $C_t$ to $i_t$ may be largely out of Fed’s control
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Building blocks

Households
• Face uninsured idiosyncratic labor income risk
• Save in two assets (liquid and illiquid), consume and supply labor

Firms
• Monopolistic competition for intermediate-good producers
• Quadratic price adjustment costs à la Rotemberg (1982)

Investment fund
• Intermediates illiquid assets/capital to producers

Government
• Issues liquid debt, spends, taxes, and transfers lump-sum

Monetary authority
• Sets nominal rate on liquid assets based on a Taylor rule

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Households

\[
\max_{\{c_t, \ell_t, \} \geq 0} \mathbb{E}_0 \int_0^\infty e^{-(\rho+\lambda) t} u(c_t, \ell_t, \ ) dt \quad \text{s.t.}
\]

\[
\dot{b}_t = r_t^b(b_t)b_t + w_t z_t \ell_t - c_t
\]

\[z_t = \text{some Markov process}\]

\[b_t \geq -b\]

- \(c_t\): non-durable consumption
- \(b_t\): liquid assets
- \(z_t\): individual productivity
- \(\ell_t\): hours worked
Households

\[
\max_{\{c_t, l_t, d_t\}_{t \geq 0}} \mathbb{E}_0 \int_0^\infty e^{-(\rho+\lambda)t} u(c_t, l_t) \ dt \quad \text{s.t.}
\]

\[
\dot{b}_t = r_t^b b_t + w_t z_t l_t \quad -d_t - \chi(d_t, a_t) - c_t
\]

\[
\dot{a}_t = r_t^a a_t + d_t
\]

\[z_t = \text{some Markov process}\]

\[b_t \geq -b, \quad a_t \geq 0\]

- \(c_t\): non-durable consumption
- \(b_t\): liquid assets
- \(z_t\): individual productivity
- \(l_t\): hours worked
- \(a_t\): illiquid assets

- \(d_t\): illiquid deposits (\(\geq 0\))
- \(\chi\): transaction cost function

Kaplan-Moll-Violante, "Monetary Policy According to HANK"
Households

\[
\max_{\{c_t, \ell_t, d_t\}_{t \geq 0}} \mathbb{E}_0 \int_0^\infty e^{-(\rho+\lambda)t} u(c_t, \ell_t) \, dt \quad \text{s.t.}
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\dot{a}_t = r^a_t a_t + d_t
\]
\[
z_t = \text{some Markov process}
\]
\[
b_t \geq -b, \quad a_t \geq 0
\]

- **Adjustment cost function**

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

- Linear component: inaction region
- Convex component: finite deposit rates

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Households

\[
\max_{\{c_t, \ell_t, d_t\}_{t \geq 0}} \mathbb{E}_0 \int_0^\infty e^{-(\rho + \lambda)t} u(c_t, \ell_t, h_t) dt \quad \text{s.t.}
\]

\[
\dot{b}_t = r^b_t(b_t)b_t + (1 - \xi)w_t z_t \ell_t - \tilde{T}(w_t z_t \ell_t) - d_t - \chi(d_t, a_t) - c_t
\]

\[
\dot{a}_t = r^a_t(1 - \omega)a_t + \xi w_t z_t \ell_t + d_t
\]

\[
h_t = \omega a_t
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- \(z_t\): individual productivity
- \(\ell_t\): hours worked
- \(a_t\): illiquid assets
- \(d_t\): illiquid deposits (\(\geq 0\))
- \(\chi\): transaction cost function
- \(\tilde{T}\): labor income tax/transfer
- \(\xi\): direct deposits
- \(h_t\): housing services
Households

$$\max_{\{c_t, \ell_t, d_t\} \geq 0} \mathbb{E}_0 \int_0^\infty e^{-(\rho+\lambda)t} u(c_t, \ell_t, h_t) dt \quad \text{s.t.}$$

$$\begin{align*}
\dot{b}_t &= r^b_t(b_t) b_t + (1 - \xi) w_t z_t \ell_t - \tilde{T}(w_t z_t \ell_t) - d_t - \chi(d_t, a_t) - c_t \\
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h_t &= \omega a_t \\
z_t &= \text{some Markov process} \\
b_t \geq -\underline{b}, \quad a_t \geq 0
\end{align*}$$

- Households are price-takers wrt: $$\{\Psi_t\}_{t \geq 0} = \{w_t, r^a_t, r^b_t, \tilde{T}_t\}_{t \geq 0}$$

- The stationary recursive solution of hh problem:
  1. decision rules: $$c(a, b, z; \Psi), d(a, b, z; \Psi), \ell(a, b, z; \Psi)$$
  2. stationary distribution: $$\mu(da, db, dz; \Psi)$$
Firms

• Representative competitive final goods producer:

\[ Y = \left( \int_{0}^{1} y_j^{\frac{\varepsilon-1}{\varepsilon}} d\varepsilon \right)^{\frac{\varepsilon}{\varepsilon-1}} \Rightarrow y_j = \left( \frac{p_j}{P} \right)^{-\varepsilon} Y \]
Firms

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• Monopolistically competitive intermediate goods producers:

  ▶ Technology: \( y_j = Z k_j^{\alpha} n_j^{1-\alpha} \Rightarrow m = \frac{1}{Z} \left( \frac{r}{\alpha} \right)^{\alpha} \left( \frac{w}{1-\alpha} \right)^{1-\alpha} \)

  ▶ Set prices subject to quadratic adjustment costs:

\[ \Theta \left( \frac{\dot{p}}{p} \right) = \frac{\theta}{2} \left( \frac{\dot{p}}{p} \right)^2 Y \]
Firms

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Exact NK Phillips curve: \( \left( r^\alpha - \frac{\dot{Y}}{Y} \right) \pi = \frac{\varepsilon}{\theta} (m - \bar{m}) + \pi \), \( \bar{m} = \frac{\varepsilon-1}{\varepsilon} \)
Competitive investment fund sector

• Own intermediate firms and issue one-period security w/ return $r^a$

• Hh productive assets $(1 - \omega) A$ are savings into this security
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- Two sources of income into the fund:
  1. Rent illiquid asset as productive capital

$$ (r^k - \delta) K $$

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  2. Receive dividends proportional to the $K$ owned

\[
q = \left[ (1 - m)Y \right] / K
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Competitive investment fund sector

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  1. Rent illiquid asset as productive capital
     \[(r^k - \delta) K\]
  2. Receive dividends proportional to the $K$ owned
     \[q = [(1 - m)Y] / K\]

- Competition among funds implies illiquid asset return
  \[r^a = (r^k - \delta) + q\]
Monetary authority and government

- Taylor rule

\[ i = \bar{r}^b + \phi \pi + \epsilon, \quad \phi > 1 \]

with \( \bar{r}^b \equiv i - \pi \) (Fisher equation)
Monetary authority and government

- **Taylor rule**
  \[ i = \bar{r}^b + \phi \pi + \epsilon, \quad \phi > 1 \]
  with \( r^b \equiv i - \pi \) (Fisher equation)

- **Progressive tax on labor income:**
  \[ \bar{T} (wz\ell) = -T + \tau wz\ell \]

- **Government budget constraint (in steady-state)**
  \[ G + T + r^b B^g = \tau \int [wz\ell (a, b, z)] \, d\mu \]
Monetary authority and government

- **Taylor rule**
  
  \[ i = \bar{r}^b + \phi \pi + \epsilon, \quad \phi > 1 \]

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- **Progressive tax on labor income:**

  \[ \tilde{T}(wz\ell) = -T + \tau wz\ell \]

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  \[ G + T + r^b B^g = \tau \int [wz\ell(a, b, z)] \, d\mu \]

- **Ricardian equivalence fails \( \Rightarrow \) this matters!**
PARAMETERIZATION
Some aspects of parameterization

- **Preferences**: GHH
Some aspects of parameterization

• **Preferences**: GHH

• Measurement and partition of asset categories into:
  
  - *liquid* (cash, bank accounts + government/corporate bonds)
  
  - *illiquid productive* (equity) vs *non-productive* (housing)
Some aspects of parameterization

- **Preferences**: GHH

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- Continuous time **household earnings dynamics**
  - Match variance and **kurtosis** of 1- and 5-yr earnings changes
  - Nature of earnings risk affects household portfolio

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- Adjustment cost function $\chi (d, a)$ and discount factor $\rho$
  - Match mean/median liquid/illiquid wealth and fraction HtM
Some aspects of parameterization

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• Production side: **standard calibration** of NK models

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Wealth distributions: Liquid wealth

Liquid wealth distribution

Liquid wealth Lorenz curve

- Top 10% share: **Model**: 87%, **SCF 2004**: 89%
- Top 1% share: **Model**: 36%, **SCF 2004**: 51%
- Gini coefficient: **Model**: 0.87, **SCF 2004**: 0.98
Wealth distributions: Illiquid wealth

- **Top 10% share:** Model: 59%, SCF 2004: 61%
- **Top 1% share:** Model: 19%, SCF 2004: 25%
- **Gini coefficient:** Model: 0.66, SCF 2004: 0.81

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MPC heterogeneity

- Realistic representation of micro consumption behavior

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RESULTS
Total effect of monetary policy shock

• Innovation $\epsilon < 0$ to the Taylor rule: $i = \bar{r}^b + \phi \pi + \epsilon$

• All experiments: $\epsilon_0 = -0.0025$, i.e. $-1\%$ annualized
Total effect of monetary policy shock

- Innovation $\epsilon < 0$ to the Taylor rule: $i = \tilde{r}^b + \phi \pi + \epsilon$

- All experiments: $\epsilon_0 = -0.0025$, i.e. $-1\%$ annualized
Transmission of monetary policy shock to $C$

\[ dC = \left( \frac{\partial C}{\partial r^b} dr^b \right)_{\text{direct}} + \left( \frac{\partial C}{\partial w} dw \right)_{\text{indirect}} + \left( \frac{\partial C}{\partial r^a} dr^a \right)_{\text{indirect}} \]
Transmission of monetary policy shock to $C$

\[ dC = \frac{\partial C}{\partial r^b} dr^b + \frac{\partial C}{\partial w} dw + \frac{\partial C}{\partial r^a} dr^a \]

**Graph:**
- Liquid return: $r^b$ (pp annual)
- Illiquid return: $r^a$ (pp annual)
- Real wage: $w$ (%)

Quarters

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Transmission of monetary policy shock to $C$

\[ dC = \left( \frac{\partial C}{\partial r^b} + \frac{\partial C}{\partial T} \frac{\partial T}{\partial r^b} \right) dr^b + \left( \frac{\partial C}{\partial w} + \frac{\partial C}{\partial T} \frac{\partial T}{\partial w} \right) dw + \frac{\partial C}{\partial r^a} dr^a \]

Transfers adjusts: **direct effect from** $r^b \downarrow$ on government debt  
**indirect effect of** $w \uparrow$ on tax revenues

Kaplan-Moll-Violante, "Monetary Policy According to HANK"
Transmission of monetary policy shock to $C$

$$dC = \left( \frac{\partial C}{\partial r^b} + \frac{\partial C}{\partial T} \frac{\partial T}{\partial r^b} \right) dr^b + \left( \frac{\partial C}{\partial w} + \frac{\partial C}{\partial T} \frac{\partial T}{\partial w} \right) dw + \frac{\partial C}{\partial r^a} dr^a$$

24% and 76%
Transmission of monetary policy shock to $C$

$$dC = \left( \frac{\partial C}{\partial r^b} + \frac{\partial C}{\partial T} \frac{\partial T}{\partial r^b} \right) dr^b + \left( \frac{\partial C}{\partial w} + \frac{\partial C}{\partial T} \frac{\partial T}{\partial w} \right) dw + \frac{\partial C}{\partial r^a} dr^a$$

24% 76%

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Transmission across the distribution: direct effects

- **Intertemporal substitution**: (+) for non-HtM
- **Income effect**: (-) for rich savers and (+) for borrowers
- **Portfolio reallocation**: (-) for those with near-zero income effect
Transmission across the distribution: indirect effects

- $c$ response to $(w_T)$ income: (+) and strong for HtM
- $c - \ell$ complementarity: (+) for non-HtM
Role of fiscal response in monetary transmission

<table>
<thead>
<tr>
<th></th>
<th>$T$ adjusts</th>
<th>$G$ adjusts</th>
<th>$B^g$ adjusts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in $r^b$ (pp)</td>
<td>-0.23%</td>
<td>-0.21%</td>
<td>-0.25%</td>
</tr>
<tr>
<td>Change in $C_0$ (%)</td>
<td>0.47%</td>
<td>0.63%</td>
<td>0.09%</td>
</tr>
<tr>
<td>Elasticity of $C_0$ to $r^b$</td>
<td>-2.10</td>
<td>-3.01</td>
<td>-0.36</td>
</tr>
</tbody>
</table>

- **$G$ adjusts**: $G$ translates 1-1 into aggregate demand
- **$B^g$ adjusts**: no direct stimulus to aggregate demand

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Concluding remarks

• Main finding
  ▶ Monetary policy transmission in HANK $\neq$ RANK
  ▶ Intertemporal subst. weak, indirect GE channels strong
  ▶ Accurate representation of hh portfolios, wealth distribution, and consumption behavior matters for monetary policy
Concluding remarks

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• Implications for conduct of monetary policy
  ▶ Key: fiscal response and functioning of markets
Concluding remarks

• Main finding
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  ▶ Intertemporal subst. weak, indirect GE channels strong
  ▶ Accurate representation of hh portfolios, wealth distribution, and consumption behavior **matters for monetary policy**

• Implications for conduct of monetary policy
  ▶ Key: fiscal response and **functioning of markets**

• Road ahead
  ▶ Forward guidance and unconventional monetary policy
  ▶ Fiscal stimulus according to HANK

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THANKS!
# Earnings dynamics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Component $j = 1$</th>
<th>Component $j = 2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrival rate $\lambda_j$</td>
<td>0.080</td>
<td>0.007</td>
</tr>
<tr>
<td>Mean reversion $\beta_j$</td>
<td>0.761</td>
<td>0.009</td>
</tr>
<tr>
<td>St. Deviation of innovations $\sigma_j$</td>
<td>1.74</td>
<td>1.53</td>
</tr>
</tbody>
</table>

- A career shock perturbed by periodic temporary shocks

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Summary of market clearing conditions

- **Liquid asset market**
  \[ B^h = B^g \]

- **Illiquid asset/capital market** → \( r^a \)
  \[ K = (1 - \omega)A \]

- **Labor market** → \( w \)
  \[ N = \int z\ell(a, b, z)d\mu \]

- **Goods market** → \( \pi \)
  \[ Y = C + H + I + G + \chi + \text{borrowing costs} + \Theta \]