Monetary Policy According to HANK

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HANK: Heterogeneous Agent New Keynesian models

- Framework for quantitative analysis of aggregate shocks and macroeconomic policy

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- Three building blocks

  1. Uninsurable idiosyncratic income risk
  2. Nominal price rigidities
  3. Assets with different degrees of liquidity

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    1. Uninsurable idiosyncratic income risk

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- Today: Transmission mechanism for conventional monetary policy

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- VAR evidence: sizable effects of monetary shocks on C

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- Consumption response to a change in real rates

$$\frac{dC}{dr} = \underbrace{\frac{\partial C}{\partial r}}_{\text{direct response to } r} + \underbrace{\frac{dY}{dr}}_{\text{GE effect on inc}} \times \underbrace{\frac{\partial C}{\partial Y}}_{\text{direct response to } Y}$$

Why HANK?

- VAR evidence: sizable effects of monetary shocks on C
- Consumption response to a change in real rates

$$\frac{dC}{dr} = \underbrace{\underbrace{\frac{\partial C}{\partial r}}_{\text{direct response to } r}}_{>95\%} + \underbrace{\underbrace{\frac{dY}{dr}}_{\text{GE effect on inc}} \times \underbrace{\frac{\partial C}{\partial Y}}_{\text{direct response to } Y}}_{<5\%}$$

- Textbook Representative Agent New Keynesian (RANK) model
  - Direct response $\frac{\partial C}{\partial r}$ is everything
  - Pure intertemporal substitution (RA Euler Equation)

Why HANK?

- Both theory and data suggest $\dfrac{\partial C}{\partial r}$ is small
  1. Macro: empirically, small sensitivity of C to r
  2. Micro: many hand-to-mouth hh for whom $\frac{\partial c}{\partial r} \approx 0$
  3. Micro: many wealthy hh for whom $\frac{\partial c}{\partial r} < 0$

- Implication: RANK parameterized to be consistent with data $\Rightarrow$ small effects of monetary policy shocks on C

- Reconcile small effects in NK model with sizable effects in data?

Why HANK?

- HANK ingredients deliver realistic distributions of $\frac{\partial c}{\partial r}$ and $\frac{\partial c}{\partial Y}$

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

- HANK generates $\frac{dC}{dr}$ as large as in data even though $\frac{\partial C}{\partial r}$ is small.

Why does this matter?

- Much more nuanced view of monetary policy
- HANK: to understand C response to monetary policy, watch labor demand, investment
- Not true in RANK model

Literature and contribution

Combine two workhorses of modern macroeconomics:

1. New Keynesian models with limited heterogeneity

   Campell-Mankiw, Gali-LopezSalido-Valles, Iacoviello, Challe-Matheron-Ragot-Rubio-Ramirez

   - micro-foundation of spender-saver behavior

2. Bewley models with sticky prices

   Oh-Reis, Guerrieri-Lorenzoni, Ravn-Sterk, Gornemann-Kuester-Nakajima, DenHaan-Rendal-Riegler,

   Bayer-Luetticke-Pham-Tjaden, McKay-Reis, McKay-Nakamura-Steinsson, Huo-RiosRull, Werning, Luetticke

   - assets with different liquidity Kaplan-Violante
   - new view of individual earnings risk Guvenen-Karahan-Ozkan-Song

- Continuous time approach Achdou-Han-Lasry-Lions-Moll

Building blocks

Households

- Face uninsured idiosyncratic labor income risk
- Consume and supply labor
- Hold two assets: liquid and illiquid

Firms

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

Assets

- Liquid assets: nominal return set by monetary policy
- Illiquid assets: real return determined by profitability of capital

Households

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

$$\dot{b}_t = r^b(b_t) b_t + \qquad w z_t \ell_t \qquad - c_t$$

$$z_t = \text{ some Markov process}$$

$$b_t \geq -\underline{b}$$

- c_t: non-durable consumption
- b_t: liquid assets
- z_t: individual productivity
- ℓ_t: hours worked
-

-
-
-
-
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-

Households

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

$$\dot{b}_t = r^b(b_t)b_t + \qquad w z_t \ell_t \qquad - d_t - \chi(d_t, a_t) - c_t$$

$$\dot{a}_t = r^a \qquad a_t \qquad + d_t$$

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- d_t: illiquid deposits ($\gtrless 0$)
- χ: transaction cost function
-
-
-
-

Households

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

$$\dot{b}_t = r^b(b_t)b_t + (1-\xi)wz_t\ell_t - T(wz_t\ell_t) - d_t - \chi(d_t,a_t) - c_t - c_t^h$$

$$\dot{a}_t = r^a(1-\omega)a_t + \xi wz_t\ell_t + d_t$$

$$h_t = c_t^h + \nu\omega a_t$$

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- T: labor income tax
- c_t^h: rentals
- h_t: housing services
- ξ: direct deposits

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$$\dot{a}_t = r^a\left(1-\omega\right) a_t + \xi w z_t \ell_t d_t$$

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Households

- Adjustment cost function

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

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

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- Recursive solution of hh problem consists of:
    1. consumption policy function $c(a, b, z; w, r^a, r^b)$
    2. deposit policy function $d(a, b, z; w, r^a, r^b)$
    3. labor supply policy function $\ell(a, b, z; w, r^a, r^b)$

  $\Rightarrow$ joint distribution of households $\mu(da, db, dz; w, r^a, r^b)$

Firms

Representative final goods producer:

$$Y = \left(\int_0^1 y_j^{\frac{\varepsilon - 1}{\varepsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon - 1}} \quad \Rightarrow \quad y_j = \left(\frac{p_j}{P} \right)^{-\varepsilon} Y$$

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Monopolistically competitive intermediate goods producers:

- Technology: $y_j = Z k_j^{\alpha} n_j^{1-\alpha} \quad \Rightarrow \quad m = \frac{1}{Z} \left(\frac{r}{\alpha} \right)^{\alpha} \left(\frac{w}{1-\alpha} \right)^{1-\alpha}$
- Set prices subject to quadratic adjustment costs:

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

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Exact NK Phillips curve:

$$\left(\rho - \frac{\dot{Y}}{Y} \right) \pi = \frac{\varepsilon}{\theta} (m - \bar{m}) + \dot{\pi}, \quad \bar{m} = \frac{\varepsilon-1}{\varepsilon}$$

Investment fund sector

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- Investment fund optimization implies illiquid asset return

$$r^a = \max_u (ru - \delta(u)) + q$$

Monetary authority and liquid assets

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

- Fisher equation $r^b = i - \pi$

- Two participants in bond market:

  Households: $B^h = \int b d\mu$

  Government: $B^g = -\bar{g}Y$

Government

- Progressive tax on labor income:

$$T(wz\ell) = -\tau_0 + \tau_1 wz\ell$$

- Steady state government budget constraint

$$G - r^b B^g = \int T(wz\ell(a,b,z))\, d\mu$$

- Out of steady state:
  1. τ_0 adjusts residually
  2. G adjusts residually
  3. B^g adjusts for first n years, then τ_0 adjusts

Summary of market clearing conditions

- Liquid asset market

$$B^h + B^g = 0$$

- Illiquid asset market

$$K = (1 - \omega)A$$

- Labor market

$$N = \int z\ell(a, b, z)d\mu$$

- Goods market:

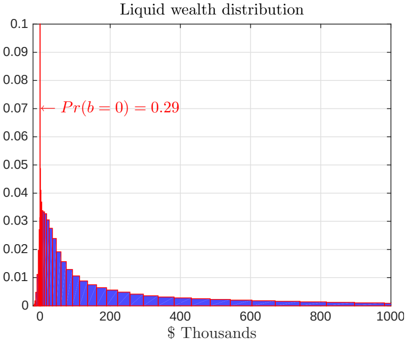
$$Y = C + H + I + G + \chi + \Theta + \text{borrowing costs}$$

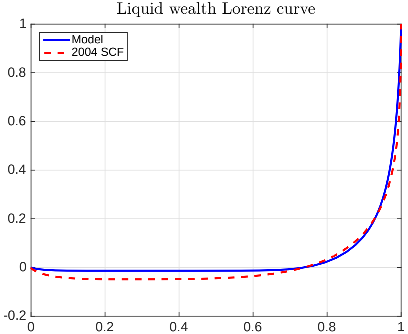
Calibration

Three particularly important aspects, relatively unique to paper:

1. Measurement and partition of asset categories
    - liquid vs illiquid
    - productive vs non-productive
    - match agg balance sheet of households in Flow of Funds
2. Adjustment cost function $\chi(d, a)$
    - target key aspects of (a, b) distribution in SCF, e.g. no of HtM
3. Continuous time household earnings dynamics

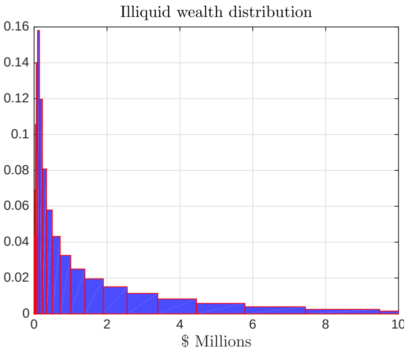
Wealth distributions: Liquid wealth

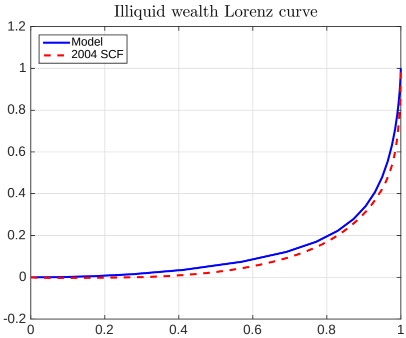




- Top 10% share: Model: 87%, SCF 2004: 89%
- Top 1% share: Model: 36%, SCF 2004: 51%
- Top 0.1% share: Model: 7%, SCF 2004: 21%

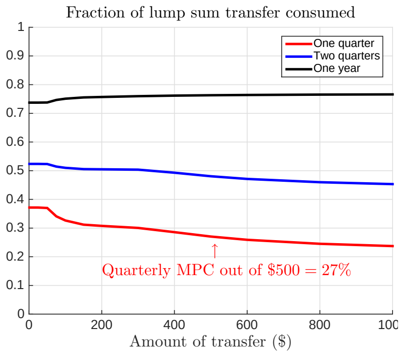
Wealth distributions: Illiquid wealth

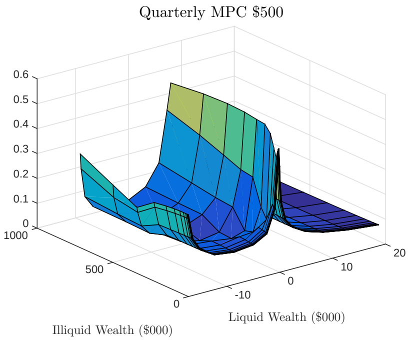




- Top 10% share: Model: 59%, SCF 2004: 61%
- Top 1% share: Model: 19%, SCF 2004: 25%
- Top 0.1% share: Model: 4%, SCF 2004: 7%

MPC heterogeneity





Channels for monetary policy

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

- All experiments: $\epsilon_0 = -0.0025$, i.e. -1% annually

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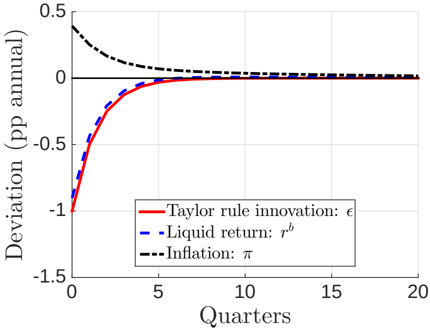
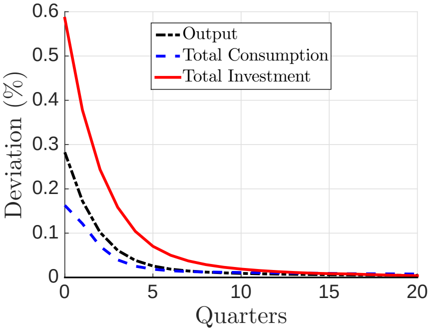
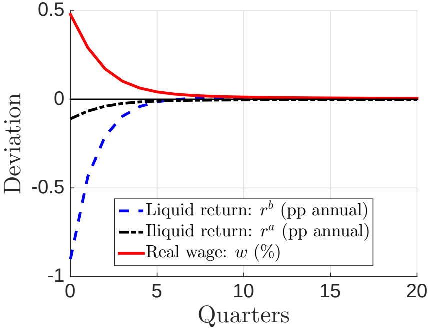
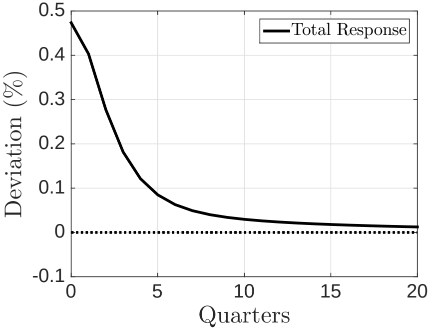




Channels for monetary policy: consumption

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

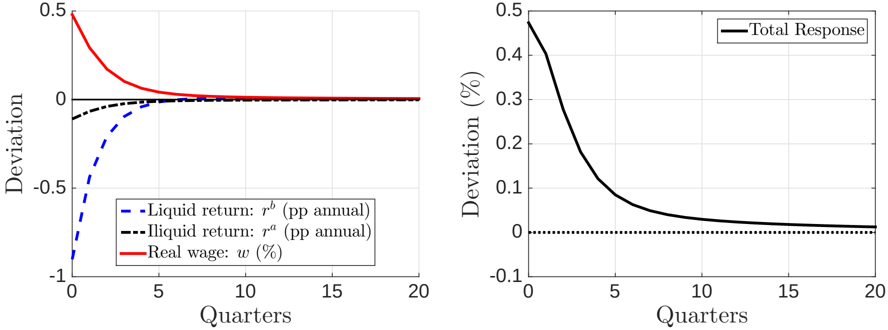




Channels for monetary policy: consumption

$$dC = \left(\frac{\partial C}{\partial r^b} + \frac{\partial C}{\partial \tau_0} \frac{\partial \tau_0}{\partial r^b} \right) dr^b + \left(\frac{\partial C}{\partial w} + \frac{\partial C}{\partial \tau_0} \frac{\partial \tau_0}{\partial w} \right) dw + \frac{\partial C}{\partial r^a} dr^a$$

Transfers adjusts: partly direct effect $r^b \downarrow$ on govt debt... partly indirect



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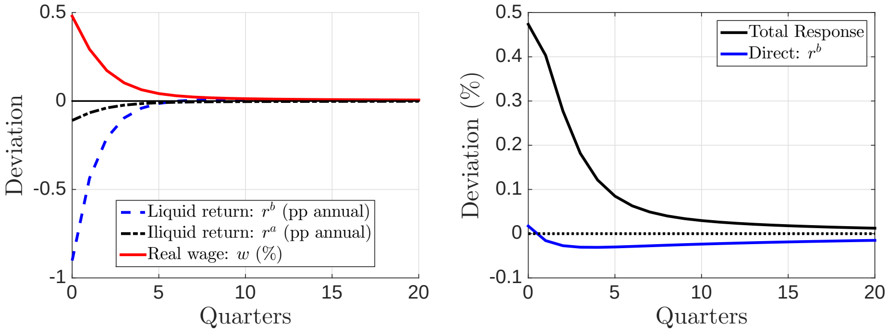
Intertemporal substitution channel: direct effects from $r^b \downarrow$



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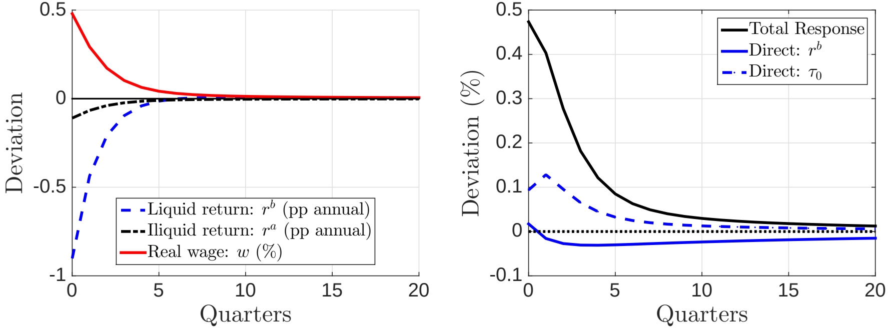
Direct effect through transfers: $r^b \downarrow$ on govt debt



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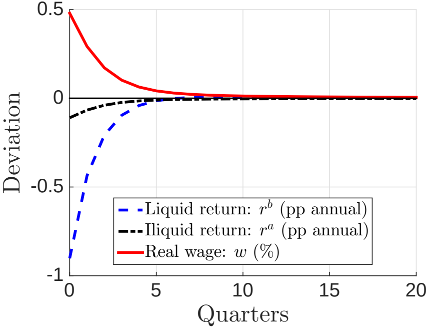
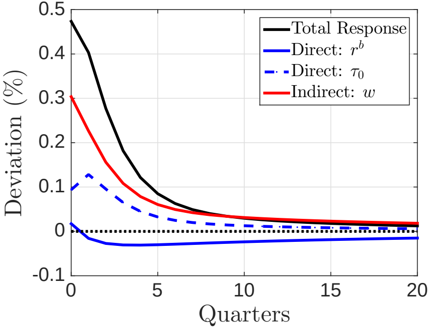
Labor demand channel: indirect effects from $w \uparrow$





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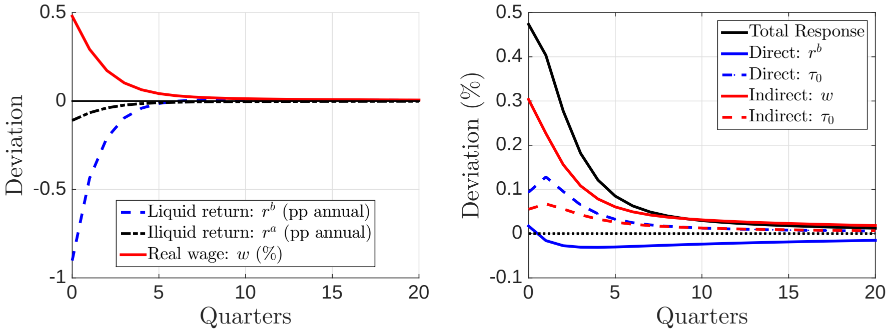

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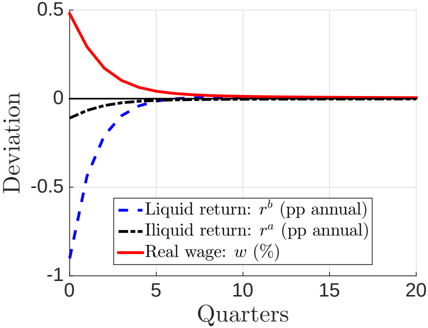
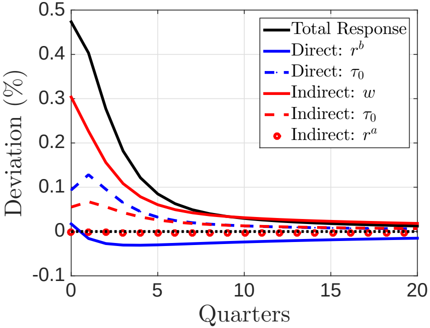
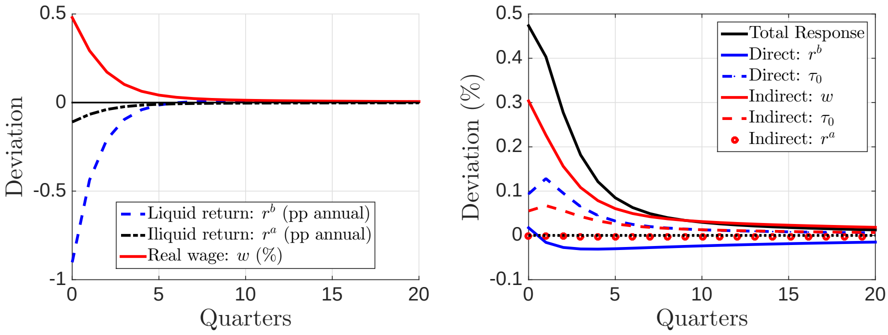
Portfolio reallocation channel: indirect effects from $r^a \uparrow$





Channels for monetary policy: consumption

$$dC = \underbrace{\left(\frac{\partial C}{\partial r^b} + \frac{\partial C}{\partial \tau_0}\frac{\partial \tau_0}{\partial r^b}\right) dr^b}_{24\%} + \underbrace{\left(\frac{\partial C}{\partial w} + \frac{\partial C}{\partial \tau_0}\frac{\partial \tau_0}{\partial w}\right) dw + \frac{\partial C}{\partial r^a} dr^a}_{76\%}$$



Monetary policy transmission mechanism

RANK model:

- Rise in C from intertemporal substitution

HANK model:

- Two (small) direct effects:
  1. Reduction in r^b triggers portfolio reallocation and increases I
  2. Lower interest on govt debt lowers T or increases G
- …trigger (large) indirect effect:
  - Rise in labor demand increases labor income $\rightarrow$ C boom

Final thoughts and road ahead

- HANK: framework for quantitative analysis of monetary policy
- Consistency with (y, b, a) and MPC distributions $\Rightarrow$

  monetary policy transmission different from standard NK models

  - to understand C response: watch labor demand, investment

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  - to understand C response: watch labor demand, investment
- Allows for analysis of distributional effects of monetary policy
- Road Ahead
  - Forward guidance and unconventional monetary policy
  - Fiscal stimulus according to HANK (fiscal policy)
  - Perturbation methods for HANK models
    $\Rightarrow$ estimation, inference