# Idiosyncratic Risk, Government Debt and Inflation

EEA-ESEM 2024

Matthias Hänsel

August 27, 2024

Stockholm School of Economics

# Introduction

# This paper

- Government debt: A concern for monetary policy?
  - High and growing debt levels in many developed countries
  - Standard models: Not if public debt funded

# This paper

- Government debt: A concern for monetary policy?
  - High and growing debt levels in many developed countries
  - Standard models: Not if public debt funded
- However, if government bonds useful for private sector *self-insurance*, the "neutral" rate changes with public debt
- If central bank does not sufficiently adapt their reaction function, *more public debt implies higher inflation*
  - Just reacting to inflation is not enough to offset variation in "neutral rate"
- This does **not** require Fiscal Dominance/FTPL $\implies$ Funded public debt can be inflationary too

# This paper (2)

- In modern 2-asset HANK models, these effects can be substantial in short/medium run
    - I illustrate this by studying debt & inflation dynamics after a fiscal expansion

# This paper (2)

- In modern 2-asset HANK models, these effects can be substantial in short/medium run
  - I illustrate this by studying debt & inflation dynamics after a fiscal expansion
- Potentially even **too** strong: Under standard assumptions, stark effects of public debt on real interest rates in state-of-the-art 2-asset HANK
  - Structure of asset market is crucial
  - ..cannot be pinned down using household micro data alone
- Important for inflation results but also other outcomes
  - e.g. fiscal costs and -sustainability, investment dynamics
- I propose a simple extension to address this issue

# Agenda

1. Literature
2. Simple Model & Sanity check
3. Quantitative model & Calibration
4. Model results: Role of the asset market
5. Model results: Fiscal shock
    - Isolating the "debt inflation"
    - Implications for monetary policy
6. (Soon: Analysis of post-Covid period)

# Literature

- Connects to vast monetary-fiscal interactions- and HANK-literature. Particularly related:

# Literature

- Connects to vast monetary-fiscal interactions- and HANK-literature. Particularly related:
  - FTPL literature: Focusses on *unfunded* debt/deficits
  - Bayer et al. (2023), Auclert et al. (2023): *Fiscal policy in 2-asset HANK*
  - Chiang and Zoch (2023): *Role of financial intermediation in 2-asset HANK*
  - Ascari and Rankin (2013), Aguiar et al. (2023): *Related results in tractable OLG frameworks*
  - Additionally, independent working paper by Campos et al. (2024) has related analysis in 1-asset HANK

# Simple Intuition & Intuition

# Households back

- Household problem:

$$\max_{\{c_{it}\}_{t=0}^{\infty}, \{N_{it}\}_{t=0}^{\infty}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\log(c_{it}) + \gamma \log(1 - N_{it})\right]$$

- Budget constraint in real terms:

$$w_t z_t N_{it} + \frac{1 + i_t}{\pi_t} b_{t-1} + T_t = c_t + b_t + z_t \tau_t$$

# Households back

- Household problem:

$$\max_{\{c_{it}\}_{t=0}^{\infty},\{N_{it}\}_{t=0}^{\infty}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\log(c_{it}) + \gamma \log(1 - N_{it})\right]$$

- Budget constraint in real terms:

$$w_t z_t N_{it} + \frac{1 + i_t}{\pi_t} b_{t-1} + T_t = c_t + b_t + z_t \tau_t$$

- No aggregate risk, all households start with $b_{-1} = 0$
- Income risk in period 0 *only*:
    - Households initially identical with $z_0 = 1$
    - With prob. $\rho^h$, $z_t = z^h \ \forall t \geq 1$, $z_t = z^l$ otherwise
    - Normalize $z_0 = \rho^h z^h + (1 - \rho^h) z^l = 1$

# Supply Side and Government

- Supply side: Off-the-shelf CES & Rotemberg setup Details

- Monetary authority determines nominal bond rate according to Taylor rule

$$i_{t+1} = r_t^* + \theta_\pi(\pi_t - 1)$$

with $\theta_\pi > 1$. $r_t^*$ are parameters with $r_t^* = \beta^{-1} - 1 \ \ \forall t \geq 1$

# Supply Side and Government

- Supply side: Off-the-shelf CES & Rotemberg setup Details

- Monetary authority determines nominal bond rate according to Taylor rule

$$i_{t+1} = r_t^* + \theta_\pi(\pi_t - 1)$$

with $\theta_\pi > 1$. $r_t^*$ are parameters with $r_t^* = \beta^{-1} - 1 \;\; \forall t \geq 1$

- Fiscal authority does the following:

  1. In $t = 0$, issue $b_0^g$ bonds, rebate proceeds back to households
  2. In $t = 1$, raise taxes $\tau = \frac{1+i_{t+1}}{\pi_{t+1}} b_0^g$ to pay back debt
  3. $\forall t > 1$: does nothing

# Model results: Summary

- In the presence of idiosyncratic risk, the neutral rate of interest increases in the level of public debt Details

# Model results: Summary

- In the presence of idiosyncratic risk, the neutral rate of interest increases in the level of public debt Details
- For given interest rate rule, higher public debt increases Inflation Details

# Model results: Summary

- In the presence of idiosyncratic risk, the neutral rate of interest increases in the level of public debt Details
- For given interest rate rule, higher public debt increases Inflation Details
- This requires neither
  - Fiscal dominance ($b_0^g$ is fully funded)
  - Ex-ante redistribution (HHs are initially identical)
  - Distortionary transfers/taxes

# How can a higher neutral rate cause inflation? Simple Intuition

- "Textbook" Taylor rule:

$$1 + i_t = \pi^* R^* + \theta_\pi(\pi_t - \pi^*)$$

$\pi^*$: Inflation target; $R^*$: Gross "natural rate"

# How can a higher neutral rate cause inflation? Simple Intuition

- "Textbook" Taylor rule:

$$1 + i_t = \pi^* R^* + \theta_\pi (\pi_t - \pi^*)$$

$\pi^*$: Inflation target; $R^*$: Gross "natural rate"

- What if real rate changes to $R(b^g)$? Can rewrite as follows:

$$1 + i_t = \tilde{\pi} R(b^g) + \theta_\pi (\pi_t - \tilde{\pi}) \quad \text{with} \quad \tilde{\pi} := \pi^* \frac{\theta_\pi - R^*}{\theta_\pi - R(b^g)} \quad .$$

## How can a higher neutral rate cause inflation? Simple Intuition

- "Textbook" Taylor rule:

$$1 + i_t = \pi^* R^* + \theta_\pi(\pi_t - \pi^*)$$

$\pi^*$: Inflation target; $R^*$: Gross "natural rate"

- What if real rate changes to $R(b^g)$? Can rewrite as follows:

$$1 + i_t = \tilde{\pi} R(b^g) + \theta_\pi(\pi_t - \tilde{\pi}) \quad \text{with} \quad \tilde{\pi} := \pi^* \frac{\theta_\pi - R^*}{\theta_\pi - R(b^g)} \quad .$$

- If $R(b^g) > R^*$ and $\theta_\pi > 1$, then $\tilde{\pi} > \pi^*$.

- Looks like a rule with a higher inflation target!

# Is the channel plausibly relevant?

- Positive medium-/long run association supported by various empirical work
  - Summary by Rachel and Summers (2019): Debt-GDP ratio $\uparrow$ 1 p.p. $\implies r^g \uparrow$ 3-6 basis points
  - In cross-country data, I find relationship of similar size if controlling for time trends
    Details

# Is the channel plausibly relevant?

- Positive medium-/long run association supported by various empirical work
  - Summary by Rachel and Summers (2019): Debt-GDP ratio $\uparrow$ 1 p.p. $\implies r^g \uparrow$ 3-6 basis points
  - In cross-country data, I find relationship of similar size if controlling for time trends Details
- How much might "implicit target" $\tilde{\pi} := \pi^* \frac{\theta_\pi - R^*}{\theta_\pi - R(b^g)}$ plausibly change due to public debt?
- $\theta_\pi = 1.5$, $R^* = 1.02^{1/4}$ (both quarterly), $\pi^* = 1.02^{1/4}$ (2% annual)
- Assume: $B^g/Y$ ratio $\Uparrow$ 1 p.p. $\Rightarrow$ ann. real rate 4 basis points $\Uparrow$
- $B^g/Y$ ratio $\Uparrow$ 10%:

# Is the channel plausibly relevant?

- Positive medium-/long run association supported by various empirical work
  - Summary by Rachel and Summers (2019): Debt-GDP ratio $\uparrow$ 1 p.p. $\implies r^g \uparrow$ 3-6 basis points
  - In cross-country data, I find relationship of similar size if controlling for time trends Details
- How much might "implicit target" $\tilde{\pi} := \pi^* \frac{\theta_\pi - R^*}{\theta_\pi - R(b^g)}$ plausibly change due to public debt?
- $\theta_\pi = 1.5$, $R^* = 1.02^{1/4}$ (both quarterly), $\pi^* = 1.02^{1/4}$ (2% annual)
- Assume: $B^g/Y$ ratio $\Uparrow$ 1 p.p. $\Rightarrow$ ann. real rate 4 basis points $\Uparrow$
- $B^g/Y$ ratio $\Uparrow$ 10%: annualized $\tilde{\pi} \approx 1.0281$ (2.81% annual) Details

# Quantitative HANK model

# The model: Big picture

- “Back-of-the-envelope” calculation suggests quantitative relevance, but is it?
  - PUblic debt $\implies$ inflation : Many reasons for comovement, potentially other mechanisms, ...
  - ..however, we can control them in a structural model.

# The model: Big picture

- "Back-of-the-envelope" calculation suggests quantitative relevance, but is it?
    - PUblic debt $\implies$ inflation : Many reasons for comovement, potentially other mechanisms, ...
    - ..however, we can control them in a structural model.

- I use a 2-asset HANK framework:
    - Features idiosyncratic labor- and profit income risk
    - 2-asset setup argued to be important for effects of fiscal policy on real returns (Bayer et al., 2023)
    - Standard frictions from "medium-scale" DSGE models
    - Calibration in line with micro-moments emphasized by literature

# Households: Overview Details HH problem

- Model features a unit mass of households $i \in [0,1]$ with utility function:

$$\mathbb{E}_t \sum_{t=0}^{\infty} \beta^t \left( \frac{c_{it}^{1-\xi} - 1}{1-\xi} - \varsigma \frac{N_{it}^{1+\gamma}}{1+\gamma} \right)$$

- Households differ by a range of individual state variables:
  - **liquid asset** holdings $a_{it} \geq \underline{a}$
  - **illiquid asset** holdings $k_{it} \geq 0$; can only be adjusted with prob. $\lambda$
  - **labor productivity** $s_{it}$; follows discrete Markov process
  - **"worker" / "entrepreneur" status** $\Xi_{it} \in \{0,1\}$, switch with exog. probs. $\zeta$ and $\iota$

- $N_{it}$ not chosen individually but by labor union. Individual (non-asset) income:

$$y_{it}(s_{it}, \Xi_{it}) = \begin{cases} (1-\tau_t)(w_t s_{it} N_t)^{1-\varpi} & \text{if } \Xi_{it} = 0 \\ (1-\tau_t \tau^{\Xi})\Pi_t^{\Xi} & \text{if } \Xi_{it} = 1 \end{cases}$$

# Model: Firms

Supply Side: Standard "medium scale" DSGE

- Final goods firms: CES aggregator, purchase inputs from retailers
- Retailers: Produce using intermediate goods; subject to Calvo-type nominal frictions Details
- Intermediate goods firm: Produce using capital $K$ and labor services $H$; choose capital utilization Details
- Investment goods firm: Turn final goods into capital; subject to real investment adjustment cost Details
- Labor packer and unions: Produce labor services; set wages nominal wages subject to nominal rigidity Details

# Model: Government

Fiscal authority:

- supplies any amount of bonds $B^g_{t+1}$ necessary to balance budget

$$B^g_{t+1} + (\mathit{tax\ revenue}) = \frac{R^B_t}{\pi_t} B^g_t + G_t + T_t$$

- Baseline: $G_t = G_{ss}\ \forall\ t$ and $T_t = 0$, budget consolidation through tax rule

$$\left(\frac{\tau_t}{\tau_{ss}}\right) = \left(\frac{\tau_{t-1}}{\tau_{ss}}\right)^{\rho_\tau} \left(\frac{B^g_t}{B^g_{ss}}\right)^{(1-\rho_\tau)\psi_B}$$

# Model: Government

Fiscal authority:

- supplies any amount of bonds $B^g_{t+1}$ necessary to balance budget

$$B^g_{t+1} + (\textit{tax revenue}) = \frac{R^B_t}{\pi_t} B^g_t + G_t + T_t$$

- Baseline: $G_t = G_{ss}\ \forall\ t$ and $T_t = 0$, budget consolidation through tax rule

$$\left(\frac{\tau_t}{\tau_{ss}}\right) = \left(\frac{\tau_{t-1}}{\tau_{ss}}\right)^{\rho_\tau} \left(\frac{B^g_t}{B^g_{ss}}\right)^{(1-\rho_\tau)\psi_B}$$

Monetary authority:

- Sets $R^B_{t+1}$ according to standard Taylor rule with rate smoothing:

$$R^B_{t+1} = (R^B_t)^{\rho_R} (R^*_{ss})^{1-\rho_R} \left(\frac{\pi_t}{\pi_{ss}}\right)^{(1-\rho_R)\theta_\pi}$$

# Model: Asset market

- Centralized market for capital. Liquid assets provided by Liquid Asset Funds (LAF):
  - Collect HH liquid assets $A_t^l$, can invest in bonds $B_t^l$ and capital $K_t^l$
  - Not subject to liquidity frictions but face cost $\varphi + \frac{\Psi}{2}\left(1 - \frac{B_t^l}{A_t^l}\right)^2$ per unit of liquidity provided.

# Model: Asset market

- Centralized market for capital. Liquid assets provided by Liquid Asset Funds (LAF):
  - Collect HH liquid assets $A_t^l$, can invest in bonds $B_t^l$ and capital $K_t^l$
  - Not subject to liquidity frictions but face cost $\varphi + \frac{\Psi}{2}\left(1 - \frac{B_t^l}{A_t^l}\right)^2$ per unit of liquidity provided.

- Why? Set-up nests different assumption on asset market in HANK literature
  - $\Psi \to \infty$ Segmented asset markets as in Kaplan et al. (2018), Bayer et al. (2023)
  - $\Psi \to 0$ Integrated asset markets as in Auclert et al. (2023)
  - Simple set-up allows moving in between without changing SS

- Ex-post return to liquid assets given by

$$R_t^a = \frac{\frac{R_t^B}{\pi_t} B_t^l + \frac{r_t + q_t}{q_{t-1}}\left(A_t^l - B_t^l\right)}{A_t^l} - \varphi - \frac{\Psi}{2}\left(1 - \frac{B_t^l}{A_t^l}\right)^2$$

# Calibration & Solution

# Calibration & Solution method

- Micro-calibration consistent with micro moments from literature Details
    - Liquid asset targets to relate to domestically held public debt.
    - Model features high MPCs ($\sim$ 19% quart.) and reasonable distribution Moments
- Various aggregate parameters set exogenously Details
    - Standard steady state parameters (depreciation, capital share, markup...)
    - Adjustment- and utilization costs from Bayer et al. (forthcoming)
- Policy:
    - Standard active Taylor rule: $\rho_R = 0.75$, $\theta_\pi = 1.5$
    - Slow fiscal consolidation: $\rho_\tau = 0.9$, $\psi_B = 0.75$
- Numerical Solution: Bayer et al. (2024) linearization method Details

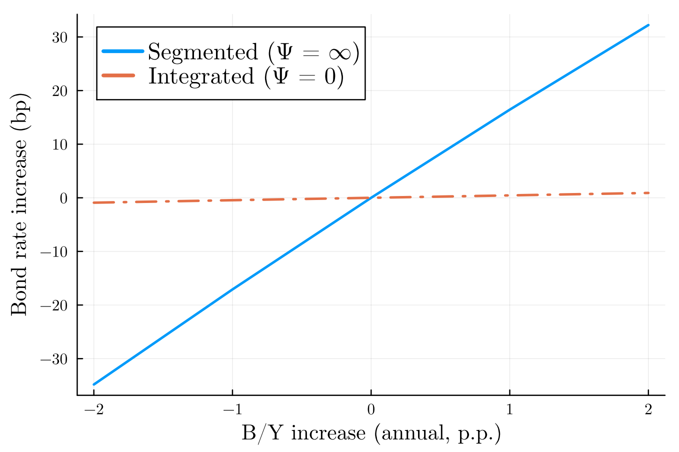
# Model Results: Gov't debt and real rates

# Public Debt and real rates in the long run

- Can 2-asset HANK relate to empirical magnitudes under standard assumptions?
  - Debt-GDP ratio $\uparrow$ 1 p.p. $\implies$ $r^b \uparrow$ 3-6 basis points

# Public Debt and real rates in the long run

- Can 2-asset HANK relate to empirical magnitudes under standard assumptions?
  - Debt-GDP ratio ↑ 1 p.p. $\implies$ $r^b$ ↑ 3-6 basis points

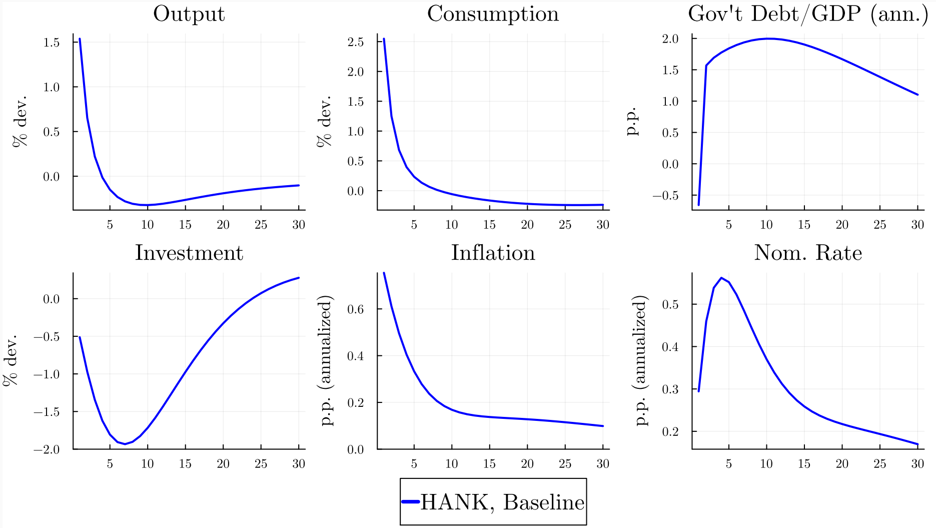


# Public Debt and real rates (2)

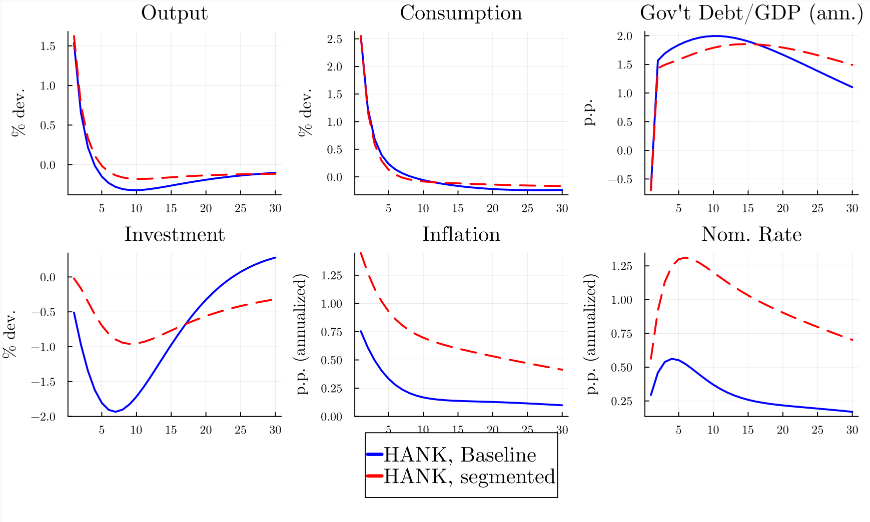
- Can 2-asset HANK relate to empirical magnitudes under standard assumptions? No!
  - Segmented asset markets: *Effect much stronger*
  - Integrated asset markets: *Effect much weaker*
- Thus: Model can be consistent with very different magnitudes
- Solution here: Choose $\Psi$ to be in line with empirical values Graph
  - Segmented model with few HtM / low MPCs can do well, but obvious calibration tradeoff
  - Potentially other solutions..

# Model Results: Fiscal Shock

# Aggregate response to a transfer shock



# Fiscal Shock: The role of the asset market



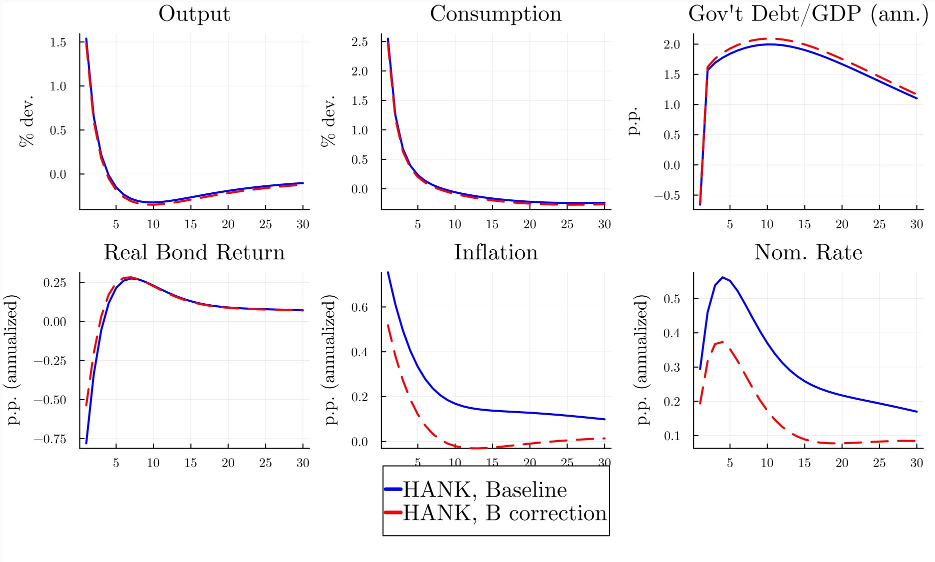
# The role of public debt

- Response seem in line with intuition
- But in complex DSGE model, couldn't there be other explanations?
- Consider the following:
  1. Approximate corrected "$R^*$" using steady state elasticity $\gamma_r = 0.0056$:

$$\log(R^*_t) = \log(R^*_{ss}) + \gamma_r(\log(B_t / Y_t) - \log(B_{ss} / Y_{ss}))$$

  2. Compare with interest rule using $R^*_t$ instead $R^*_{ss}$
     - In this case, CB reacts to public debt even if *no inflation*
  3. Can also compare with implicit $\tilde{\pi} := \pi_{ss}\frac{\theta_\pi - R^*_{ss}}{\theta_\pi - R^*_t}$ from simple formula Graph

# Fiscal Shock: “Debt” inflation



# Implications for monetary policy

# What can monetary policy do?

- Central banks might want to counteract inflationary pressure of public debt
  - However, “neutral rate” or relevant elasticities hard to measure in practice
  - Effectiveness requires public to know CB stance w.r.t. public debt Details

# What can monetary policy do?

- Central banks might want to counteract inflationary pressure of public debt
  - However, "neutral rate" or relevant elasticities hard to measure in practice
  - Effectiveness requires public to know CB stance w.r.t. public debt Details

- Can simpler rules work as well? Various alternatives, e.g.

1. A "hawkish" rule (e.g. $\theta_\pi = 2$) Details
   - Reduces overall magnitude, but not persistence

2. Use *realized* real rate $\frac{R_t^B}{\pi_t}$ as $R^*$ in interest rate rule Details
   - Implication: Keep raising $R^B$ as long as $\pi_t$ over target

# Concluding remarks

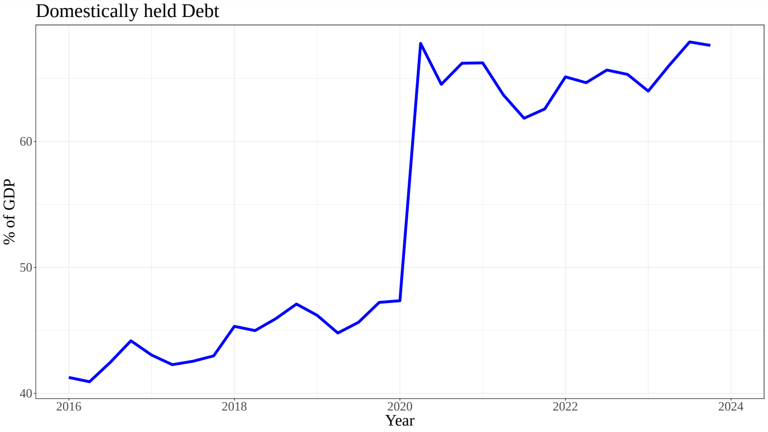
- In the presence of idiosyncratic risk, public debt can create inflation
  - Consistent with active monetary policy
  - Key channel: $B^g \uparrow \implies r^l \uparrow$
- Magnitude depends on structure of the asset market
  - Baseline calibration: Magnitude moderate
  - But persistently elevated debt $\implies$ persistently elevated inflation.
- CB can counteract "debt inflation" by reacting to public debt or real bond returns
- We should think more about modelling asset markets in rich HANK models

# T**HANK** you for your attention!

matthias.hansel@hhs.se
mhaense1.github.io

# Appendix

# More US gov't debt




back calibration Source: FRED. Defined as FYGFDPUN (federal debt held by the public) minus FDHBFIN (fed. debt held by foreign and international investors) over GDP.

# More US gov't debt


back

# Details "Back of the enveloppe" calculation

- Start with $R^*{=}R(b^g) = 1.01$
- Assumption: Annual $R^a(b^g)$ increases by 0.0004 for every 1% increase in $b^g/Y$
  $\implies$ New quarterly $R(b^g) = (1.02 + 10 \times 0.0004)^{1/4}$
- Resulting annualized $\tilde{\pi}$:

$$\tilde{\pi} = \left(\pi^* \frac{\theta^\pi - R^*}{\theta^\pi - R(b^g)}\right)^4 \approx 1.0281$$

back

# Supply side back

- Final good produced using intermediate inputs $y_t(j)$:

$$Y_t = \left[ \int_0^1 y_t(j)^{\frac{\epsilon-1}{\epsilon}} dj \right]^{\frac{\epsilon}{\epsilon-1}}$$

- Every variety $j$ is produced by a monopolist
  - Owned by risk-neutral entrepreneurs discounting future at rate $\beta$

- Monopolists maximize profits subject to Rotemberg (1982) adjustment costs

$$\max_{\{p_t(j)\}_{t\geq 0}} \sum_{t=0}^{\infty} \mathbb{E}_0 \beta^t \left[ (p_t(j) - w_t) \left[ \frac{p_t(j)}{P_t} \right]^{-\epsilon} Y_t - \frac{\phi}{2} \left( \frac{p_t(j)}{p_{t-1(j)}} - 1 \right)^2 Y_t \right]$$

# Analytical Model: "Natural rate"

## Lemma

*In period 0, the natural rate of interest $r_0^n$ is implicitly characterized by*

$$\frac{\epsilon}{\epsilon-1} = \beta\rho^h \frac{1+r_0^n}{\frac{\epsilon-1}{\epsilon} z^h + \frac{r_1^*}{1+r_1^*}\left(1+r_0^n\right) b_0^g (1-z^h)} + \beta(1-\rho^h)\frac{1+r_0^n}{\frac{\epsilon-1}{\epsilon} z^l + \frac{r_1^*}{1+r_1^*}\left(1+r_0^n\right) b_0^g (1-z^l)}$$

back

# Cross-country regression results back

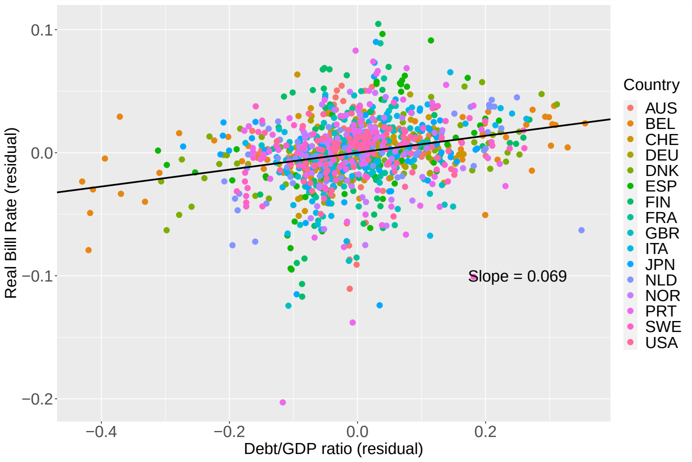



**Figure 1:** Data source: MacroHistory Database (Jorda et al., 2017)

# Household problem in recursive form

- Only show capital adjuster problem:

$$V_t^a(a_{it}, k_{it}, s_{it}, \Xi_{it}) = \max_{a_{it+1}, k_{it+1}} \{u(c_{it}) - \nu(N_t) + \beta \mathbb{E}_t V_{t+1}(a_{it+1}, k_{it+1}, s_{it+1}, \Xi_{it+1})\}$$

$$\text{s.t.} \quad c_{it} + a_{it+1} + q_t k_{it+1} = a_{it} R_t^a(a_{it}) + (q_t + r_t) k_{it} + y_{it}(N_t, s_{it}, \Xi_{it}) + T_t \quad ,$$

$$a_{it+1} \geq \underline{a}, \;\; k_{it+1} \geq 0$$

- Income is given by

$$y_{it}(s_{it}, \Xi_{it}) = \begin{cases} (1 - \tau_t)(w_t s_{it} N_t)^{1-\varpi} & \text{if } \Xi_{it} = 0 \\ (1 - \tau_t \tau^{\Xi}) \Pi_t^{\Xi} & \text{if } \Xi_{it} = 1 \end{cases}$$

- Liquid return is given by

$$\tilde{R}_t^a(a_{it}) = R_t^a + \mathbb{1}_{a_{it} < 0} \bar{R}$$

back

# Supply Side: Final Good & Retailers

- Final goods: As in simple model
- Retailers: Monopolistic competition, take into account demand curve

$$y_{jt} = \left(\frac{p_{jt}}{P_t}\right)^{-\epsilon_t} Y_t$$

- Produce using homogenous intermediate goods, choose price subject to Calvo-type adjustment frictions, i.e. solve

$$\max_{p_{jt}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \lambda_Y^t Y_t \left[\left(\frac{p_{jt}\bar{\pi}_Y^t}{P_t} - mc_t\right)\left(\frac{p_{jt}\bar{\pi}^t}{P_t}\right)^{-\eta_t}\right] \quad .$$

$mc_t$: Price of intermediate

back

# Supply side: Intermediate goods firm

- Take capital rental rate $r_t$, price of labor services $h_t$ and output price $mc_t$ as given, solve

$$\max_{H_t, K_t, u_t} mc_t Z_t (u_t K_t)^{\alpha} H_t^{1-\alpha} - h_t H_t - (r_t + q_t \delta(u_t)) K_t$$

- Depreciation determined by capacity utilization $u_t$ according to

$$\delta(u_t) = \delta_0 + \delta_1 (u_t - 1) + \frac{\delta_2}{2} (u_t - 1)^2$$

back

# Details: Investment goods firm

- Investment firms take capital price $q_t$ as exogenous, choose $\{I_t\}_{t=0}^{\infty}$ to solve

$$\max \mathbb{E} \sum_{t=0}^{\infty} \beta^t I_t \left\{ q_t \left[ 1 - \frac{\phi}{2} \left( \log \frac{I_t}{I_{t-1}} \right)^2 \right] - 1 \right\}$$

- Law of motion of aggregate capital stock

$$K_{t+1} = (1 - \delta(u_t))K_t + I_t \left[ 1 - \frac{\phi}{2} \left( \log \frac{I_t}{I_{t-1}} \right)^2 \right]$$

back

# Details: Labor Packer and Unions

- Each HH is part of a union that supplies a specific variety of labor
  - Members of a union $u$ are required to work the same hours $N_{ut}$.

- A competitive "labor packer" assembles the varieties with a CES technology

$$H_t = \int_0^1 N_{ut}^{\frac{\epsilon_h - 1}{\epsilon_h}} du \implies \text{Demand schedule:} \quad N_{ut} = \left(\frac{w_{ut}}{h_t}\right)^{-\epsilon_h} H_t$$

- Union leadership chooses wage subject to Rotemberg-style nominal rigidty:

$$\max_{w_t} \sum_{t=0}^{\infty} \beta^t \left( \underbrace{\int \left[ u(c_{ut}(w_{ut} N_{ut}, ..)) - \varsigma \frac{N_{ut}(w_{ut})^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}} \right] di}_{=\text{avg. felicity of union members}} - \frac{\kappa_w}{2} \left( \frac{w_t}{w_{t-1}} \pi_t \right)^2 \right)$$

F.O.C. gives rise to standard wage Philips curve

back

# "Micro" calibration back

- Attempt to be consistent with micro moments from the literature
- Risk aversion $\xi$ set to 1.5; income process as in Bayer et al. (forthcoming)
- $B^g/Y = 0.43$ target reflects US average 1950-2019
  - Also, *domestically held* public debt to GDP was around 45% pre-Covid Graph
- Endogenous calibrated parameters: Details

| Parameter | Description | Target | Value |
|---|---|---|---|
| $\beta$ | Discount factor | $K/Y = 11.44$ | 0.982 |
| $\lambda$ | Capital Liquidity | Annual $B^g/Y = 0.43$ | 0.034 |
| $\zeta$ | "Entrepreneur" prob. | Top 10 Wealth Share 70% | 0.0005 |
| $\bar{R}$ | Borrowing penalty | Borrower share 16% | 0.038 |

- Model features high MPCs ($\sim$ 19% quart.) and reasonable distribution Moments

# Details Calibration: Externally set parameters

| Parameter | Description | Value | Source |
|---|---|---|---|
| $\xi$ | risk aversion | 1.5 | Standard |
| $\iota$ | Exit prob. entrpreneurs | 1/16 | Bayer et al. (2022) |
| $\alpha$ | Cobb-Douglas parameter | 0.32 | Standard |
| $\phi$ | investment adjustment cost | 3.5 | Bayer et al. (2022) |
| $\gamma$ | labor supply parameter | 1/0.5 | Standard |
| $\mu_g$ | SS goods markup | 1.1 | Standard |
| $\kappa_Y$ | Slope of NK Philips curve | 0.08 | Standard |
| $\epsilon_h/\kappa_w$ | Slope of NK wage Philips curve | 0.04 | |
| $\delta_0$ | Steady State depreciation | 0.0155 | Standard |
| $\delta_2/\delta_1$ | utilization parameters | 1.0 | Bayer et al. (2022) |
| $\tau_{ss}$ | income tax level | 0.2 | Standard |
| $\varpi$ | labor tax progrssivity | 0.12 | Ferriere and Navarro (2023) |
| $(\rho_\tau, \psi_B)$ | Gov't spending rule | (0.9, 0.75) | |
| $(\rho_R, \theta_\pi)$ | Taylor rule parameters | (0.75,1.5) | Standard |
| $(R^a_{ss}, \pi_{ss})$ | SS liquid rate& inflation | (1.0, 1.0) | Bayer et al. (2022) |

back

# Details Calibration: Internally calibrated

| Parameter | Description | Value | Target |
|---|---|---|---|
| $\beta$ | discount factor | 0.982 | $K/Y = 11.44$ |
| $\zeta$ | entry prob. entrepreneurs | 0.0005 | Top 10 wealth share 70% |
| $\bar{R}$ | borrowing penalty | 0.038 | 16% borrower share |
| $\lambda$ | illiquid asset adjustment prob. | 0.034 | $A^l/Y = 1.72$ |
| $\underline{a}$ | borrowing limit | -1.4 | 100% of avg. after-tax income |
| $\varphi$ | Liquidity Wedge | 0.0104 | $B^g_{ss} = A^l_{ss}$ |
| $\Psi$ | Capital liquidity | 0.0075 | real rate response to $B^g$ |
| $\varsigma$ | Disutility of labor | 0.591 | $N_{ss} = 1$ |

back

# Fit distributional moments (1)

| | Disposable Income | | Net Worth | |
|---|---|---|---|---|
| | Model | Data | Model | Data |
| Quint. 1 | 6.7 | 4.5 | 0.0 | -0.2 |
| Quint. 1 | 10.7 | 9.9 | 1.1 | 1.2 |
| Quint. 3 | 14.7 | 15.3 | 3.9 | 4.6 |
| Quint. 4 | 20.4 | 22.8 | 10.3 | 11.9 |
| Quint. 5 | 47.3 | 47.5 | 84.5 | 82.5 |
| Gini | 0.40 | 0.42 | 0.80 | 0.78 |

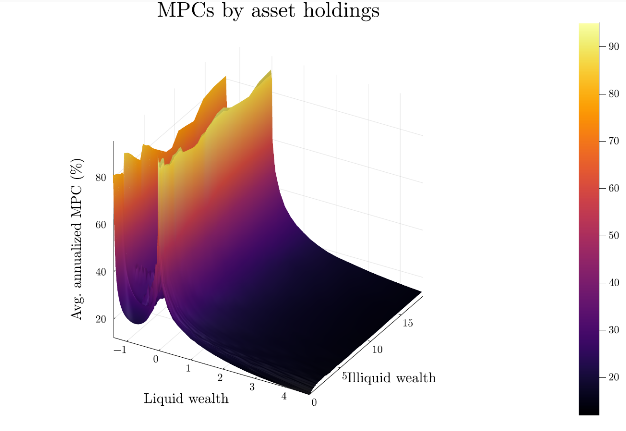
Note: "Data" refers to moments computed by Krueger et al. (2016) using PSID and SCF.

back

# Fit distributional moments (2) back

| Moments | Model | Data (incl. source) |
|---|---|---|
| *Illiquid asset shares* | | Kaplan et al. (2018) |
| Top 10% | 66.8 | 70 |
| Next 40% | 31.9 | 27 |
| Bottom 50% | 1.3 | 3 |
| *Liquid asset shares* | | Kaplan et al. (2018) |
| Top 10% | 78.3 | 86 |
| Next 40% | 21.3 | 18 |
| Bottom 50% | 0.4 | -4 |
| *Hand-to-Mouth (HtM) Status* | | Kaplan et al. (2014) |
| Share HtM | 33.9 | 31.2 |
| Share Wealthy HtM | 20.9 | 19.2 |
| Share Poor HtM | 13.0 | 12.1 |

# Consumption moments




- Average MPC: 19.3 % quarterly, 41.6 % annualized

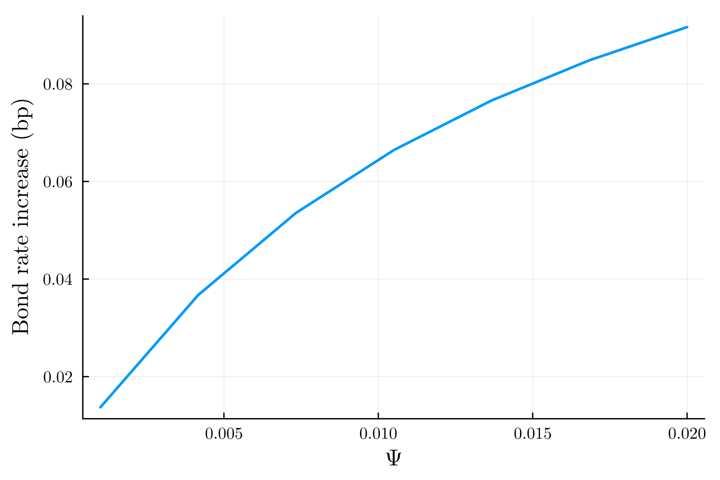
back

# Solution method

- For steady state, use multi-dimensional Endogenous Grid Method for HH problem and Young (2010) histogram method for distribution
- Obtain dynamic response with a variant of the Bayer and Luetticke (2020) method $\Longrightarrow$ First-Order Perturbation around non-stochastic steady state
- With my $80 \times 80 \times 16$ tensor grid for HH problem, discretized model has in principle huge system of equations ($> 300,000$)
- **Need dimension-reduction:**
  - Split joint distribution(s) into Copula(s) and marginal distributions
  - Sparse approximations of (marginal) value functions and Copula(s) using Discrete Cosine Transform (DCT)
  - $\Longrightarrow$ Reduce dimensionality to around 800

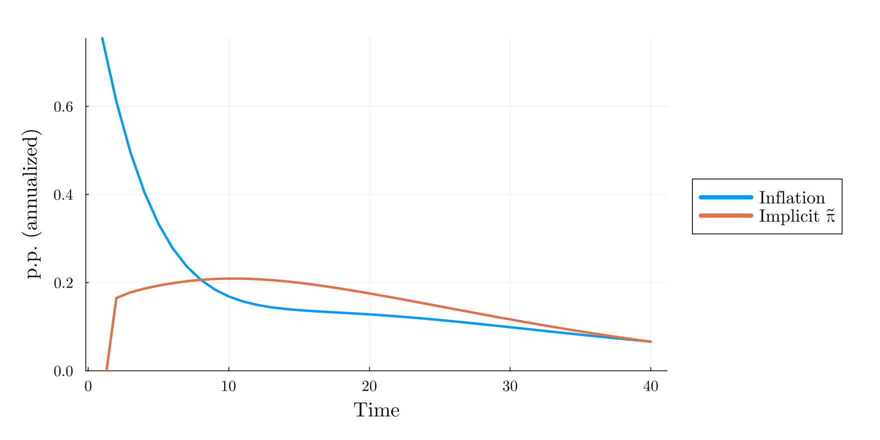
back

# Public Debt and real rates by $\Psi$



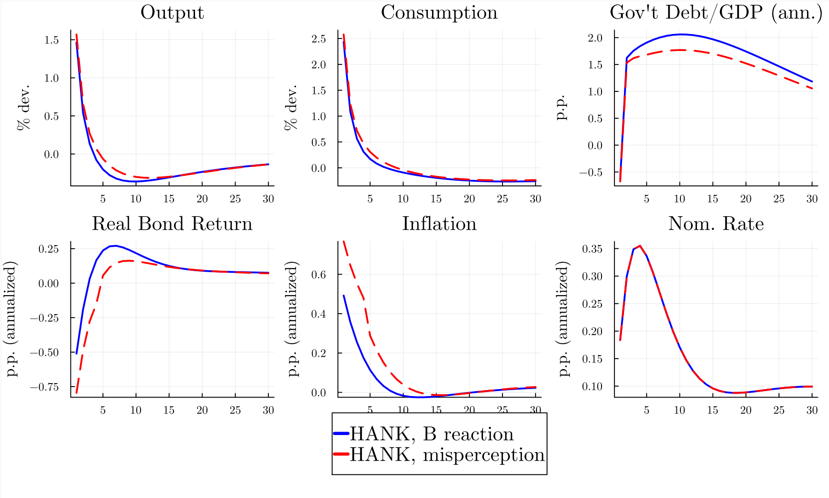

- Baseline model: $\Psi = 0.0075$ back

# Fiscal Shock: Implicit “Debt Inflation”



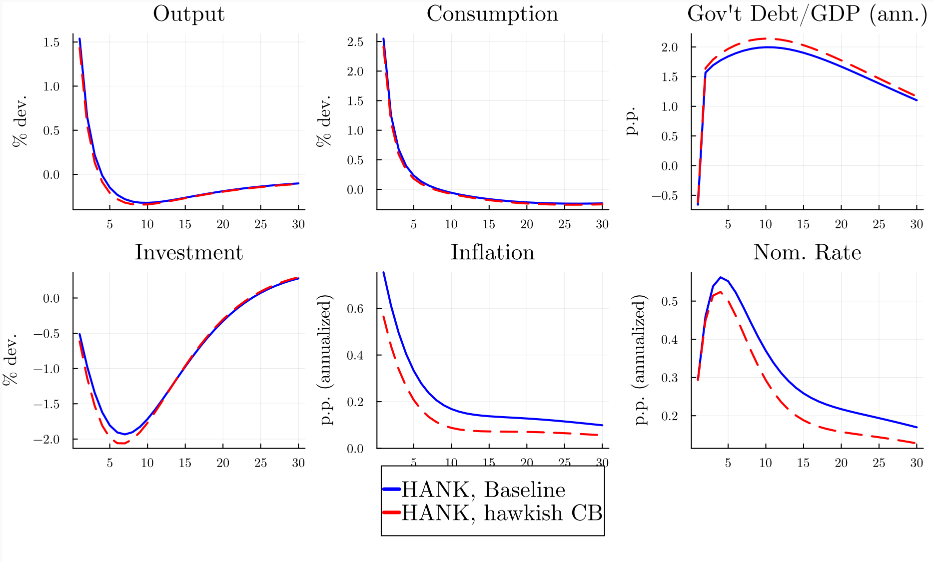

- Steady State liquid return elasticity predicts medium term inflation well back

# Misinterpreted CB rule Back



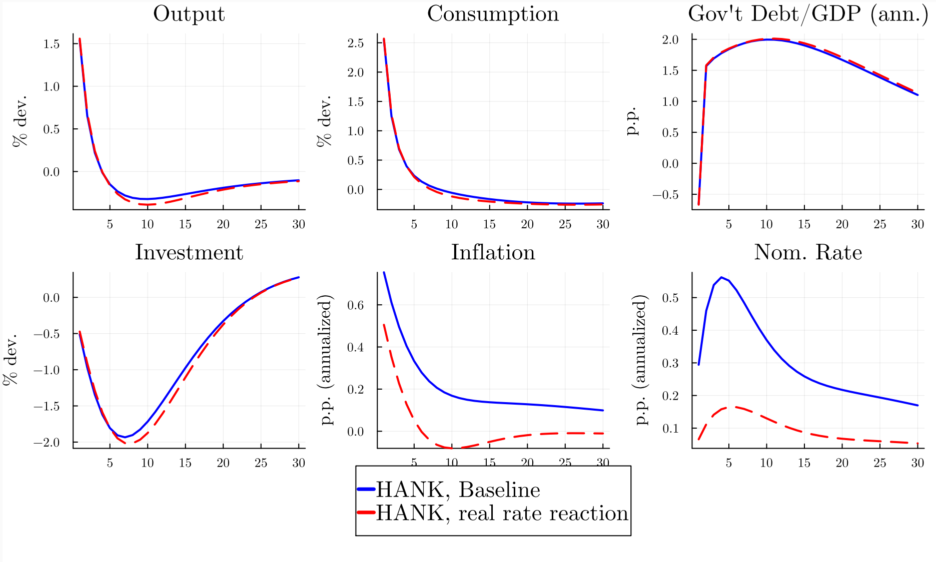

- Red dashed line: Public understands CB “debt reaction” only after 4 quarters

# Effects of Hawkish rule ($\theta_\pi = 2$) Back



# Effects of Real Rate Reaction

Back



# Appendix: Analytical Model

# Model Results (1)

- "Neutral rate" $r_0^n$: Nominal rate so that $\pi_0 = 1$.

## Proposition (1)

*Assume* $b_g^0 \in \left[0, \frac{\epsilon-1}{\epsilon}\frac{\beta}{1-\beta}\right)$. *In that case, the neutral rate implicitly defined in* Lemma 1 *fulfills*

$$\frac{\partial r_0^n}{\partial b_0^g} > 0 \quad ,$$

*i.e. the neutral rate of interest in period* 0 *is increasing in the level of government debt issued.*

back

# Model Results (2)

## Proposition (2)

*Assume that $r_0^*$ is fixed at the neutral rate $r_0^n(\bar{b})$, as implicitly defined in* Lemma 1*, for some given level $\bar{b} \in \left[0, \frac{\epsilon-1}{\epsilon}\frac{\beta}{1-\beta}\right)$ of government debt to be issued in period 0. Then,*

$$\left.\frac{\partial \pi_t}{\partial b_0^g}\right|_{b_0^g=\bar{b}} > 0 \quad ,$$

*i.e. inflation increases in the amount of government debt.*

back