Monetary Policy and Wealth Effects: The Role of Risk and Heterogeneity

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Monetary Policy and Wealth Effects

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Modern evidence: monetary policy affects **risk premia** on stocks and bonds

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Two views on how asset prices affect the **real economy**

1. Changes in asset prices create a **wealth effect**
    - Cieslak and Vissing-Jorgensen (2020); Chodorow-Reich et al (2020)

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1. Changes in asset prices create a **wealth effect**
   - Cieslak and Vissing-Jorgensen (2020); Chodorow-Reich et al (2020)
2. Changes in asset prices reflect movements in "**paper wealth**"
   - Cochrane (2020); Krugman (2021); Fagereng et al. (2022)

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This paper: how MP affects the real economy through wealth effects

- Two main ingredients: rare disasters and heterogeneous beliefs
- Movements in nominal rates lead to changes in equity and term premia

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   - Under special conditions, variations in risk premia have no effect on real economy

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    - Time-varying risk premia and precautionary motive with first-order approximation
2. The **risk-premium neutrality** result
    - Under special conditions, variations in risk premia have no effect on real economy
3. Quantify importance of time-varying risk premia
    - Changes in asset prices are the main driver of consumption and inflation response.

Model

The Model

- **Households**: *workers*, *optimistic savers*, and *pessimistic savers*
    - Workers are hand-to-mouth and the only ones who supply labor
    - Savers invest on short-term bonds, long-term bonds, and equities

- **Firms**: sticky prices
    - Intermediate-goods producers face aggregate disaster risk
    - Shock with Poisson intensity $\overline{\lambda} \geq 0$ permanently reduces productivity

- **Government**: fiscal and monetary policy
    - Fiscal: lump-sum transfers and long-term debt
    - Monetary: standard interest rate rule

Savers' problem

Problem of saver $j \in \{o, p\}$:

$$V_{j,t}(B_{j,t}) = \max_{[B^L_{j,z}, B^E_{j,z}, C_{j,z}]_{z \geq t}} \mathbb{E}_{j,t} \left[\int_t^{t^*} e^{-\rho_j (z-t)} \frac{C_{j,z}^{1-\sigma}}{1-\sigma} dz + e^{-\rho_j (t^* - t)} V^*_{j,t^*}(B^*_{j,t^*}) \right],$$

subject to

$$dB_{j,t} = \left[(i_t - \pi_t) B_{j,t} + r_{L,t} B^L_{j,t} + r_{E,t} B^E_{j,t} - C_{j,t} + T_{j,t} \right] dt + \left[B^*_{j,t} - B_{j,t} \right] d\mathcal{N}_t,$$

with subjective disaster probability λ_j.

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$$r_{L,t} \equiv \frac{1}{Q_{L,t}} + \frac{\dot{Q}_{L,t}}{Q_{L,t}} - \psi_L - i_t$$

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$$r_{E,t} \equiv \frac{\Pi_t}{Q_{E,t}} + \frac{\dot{Q}_{E,t}}{Q_{E,t}} - (i_t - \pi_t)$$

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$$B^*_{j,t} - B_{j,t} = B^L_{j,t} \frac{Q^*_{L,t} - Q_{L,t}}{Q_{L,t}} + B^E_{j,t} \frac{Q^*_{E,t} - Q_{E,t}}{Q_{E,t}}$$

Euler equations

Short-term bonds:

$$\frac{\dot{C}_{j,t}}{C_{j,t}} = \underbrace{\sigma^{-1}(i_t - \pi_t - \rho_j)}_{\text{intertemporal substitution}} + \underbrace{\frac{\lambda_j}{\sigma}\left[\left(\frac{C^*_{j,t}}{C_{j,t}}\right)^{-\sigma} - 1\right]}_{\text{precautionary savings}}$$

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Long-term bonds:

$$r_{L,t} = \underbrace{\lambda_j \left(\frac{C^*_{j,t}}{C_{j,t}}\right)^{-\sigma}}_{\substack{\text{price of} \\ \text{disaster risk}}} \underbrace{\frac{Q_{L,t} - Q^*_{L,t}}{Q_{L,t}}}_{\substack{\text{quantity of} \\ \text{risk}}}$$

Equities:

$$r_{E,t} = \lambda_j \left(\frac{C^*_{j,t}}{C_{j,t}}\right)^{-\sigma} \frac{Q_{E,t} - Q^*_{E,t}}{Q_{E,t}}.$$

Market-implied disaster probability and the SDF

Define average savers' consumption as $C_{s,t} \equiv \frac{\mu_o}{\mu_o + \mu_p} C_{o,t} + \frac{\mu_p}{\mu_o + \mu_p} C_{p,t}$

- It is convenient to price assets using $C_{s,t}$
- Define the economy's SDF as $\eta_t = e^{-\int_0^t \rho_{s,t}} C_{s,t}^{-\sigma}$

Given this SDF, the **market-implied disaster probability** is given by

$$\lambda_t \equiv \left[\frac{\mu_o C_{o,t}}{\mu_o C_{o,t} + \mu_p C_{p,t}} \lambda_o^{\frac{1}{\sigma}} + \frac{\mu_p C_{p,t}}{\mu_o C_{o,t} + \mu_p C_{p,t}} \lambda_p^{\frac{1}{\sigma}} \right]^{\sigma}$$

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The market-implied disaster probability is potentially *time-varying*

- It increases if optimistic investors lose consumption share

Firms' problem

Firms:

- Final-goods producers: competitive, combine intermediate goods according to CES.
- Intermediate-goods producers: differentiated good, monopolistically competitive.
  - Subject to TFP shock. Poisson intensity $\bar{\lambda}$:

$$A_t = A \to A_{t^*} = A^* < A.$$

  - Rotemberg price adjustment costs.

New Keynesian Phillips Curve:

$$\dot{\pi}_t = \left(i_t - \pi_t + \lambda_t \frac{\eta_t^*}{\eta_t} \right) \pi_t - \varphi^{-1}(\epsilon - 1) \left(\frac{\epsilon}{\epsilon - 1} \frac{W_t}{P_t} \frac{1}{A} - (1 - \tau) \right) Y_t,$$

Workers and government

Workers:

- GHH preferences and hand-to-mouth
- Labor supply: $\dfrac{W_t}{P_t} = N_{w,t}^{\phi}$

Fiscal policy:

$$\dot{D}_{G,t} = (i_t - \pi_t + r_{L,t})D_{G,t} + \sum_{j \in \{w,o,p\}} \mu_j T_{j,t},$$

and No-Ponzi condition $\lim_{t \to \infty} E_0[\eta_t D_{G,t}] \leq 0$.

Monetary policy:

$$i_t = r_n + \phi_\pi \pi_t + u_t,$$

where $\phi_\pi > 1$. After the disaster shock, $i_t^* = r_n^* + \phi_\pi \pi_t^*$.

Equilibrium Characterization

Solution method

Solution method:

- Standard approach: approximate around non-stochastic steady state $(\lambda_t = u_t = 0)$.
- **This paper:** linearize around **stationary equilibrium** with $\lambda_t = \lambda > 0$, $u_t = 0$.
    - All variables are constant in **each** aggregate state.
    - Capture time-varying precautionary savings and risk premia in a **linear** setting.

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Stationary equilibrium:

$$r_n = \rho_s - \lambda \left[\left(\frac{C_s}{C_s^*} \right)^{\sigma} - 1 \right], \qquad r_L = \lambda \left(\frac{C_s}{C_s^*} \right)^{\sigma} \frac{Q_L - Q_L^*}{Q_L}, \qquad r_E = \lambda \left(\frac{C_s}{C_s^*} \right)^{\sigma} \frac{Q_E - Q_E^*}{Q_E}.$$

- Precautionary motive depresses natural interest rate
- Upward-sloping yield curve and positive equity premium

Aggregate dynamics

Aggregate Euler equation:

$$\dot{y}_t = \tilde{\sigma}^{-1} \, (i_t - \pi_t - r_n) \, + \, \delta \, y_t + \, \chi_\lambda \hat{\lambda}_t \, .$$

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macro-EIS

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δ → discounting

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New Keynesian Phillips curve:

$$\dot{\pi}_t = \rho \pi_t - \kappa y_t .$$

Asset prices

Monetary policy affects the valuation of assets.

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Price of risk:

$$p_{d,t} \equiv \underbrace{\sigma(c_{s,t} - c^*_{s,t})}_{\text{change in marginal utility}} + \underbrace{\hat{\lambda}_t}_{\text{market-implied disaster probability}} \quad .$$

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Long-term bonds:

$$q_{L,0} = -\underbrace{\int_0^\infty e^{-(\rho+\psi_d)t}(i_t - r_n)dt}_{\text{short-term rates}} - \underbrace{\int_0^\infty e^{-(\rho+\psi_d)t} r_L p_{d,t} dt}_{\text{term premium}},$$

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Stocks:

$$q_{E,0} = \underbrace{\frac{Y}{Q_E}\int_0^{\infty} e^{-\rho t}\hat{\Pi}_t dt}_{\text{dividends}} - \underbrace{\int_0^{\infty} e^{-\rho t}\left(i_t - \pi_t - r_n + r_E p_{d,t}\right) dt}_{\text{discount rate}} .$$

The approximate block recursivity property

To obtain $\hat{\lambda}_t$, we need relative consumption

$$\hat{\lambda}_t \propto \left(\lambda_p^{\frac{1}{\sigma}} - \lambda_o^{\frac{1}{\sigma}} \right) [c_{p,t} - c_{o,t}]$$

This requires solving for *relative net worth* $b_{p,t} - b_{p,o}$

- In principle, need to solve for $[c_{p,t} - c_{o,t}, b_{p,t} - b_{o,t}]$ and $[y_t, \pi_t]$ simultaneously
- **Important property:** system is **block recursive** if $r_k \sigma c_{s,t}$ is small
  - Consumption fluctuations in normal times have negligible effect on risk premia

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Proposition (Approximate block recursivity)

Suppose the term $r_k \sigma c_{s,t} = \mathcal{O}(||i_t - r_n||^2)$ *for* $k \in \{L, E\}$*. Then,* $\hat{\lambda}_t$ *is given by*

$$\hat{\lambda}_t = e^{-\psi_\lambda t} \underbrace{\epsilon_\lambda (i_0 - r_n)}_{\hat{\lambda}_0},$$

where $\psi_\lambda \geq 0$ *and* $\epsilon_\lambda \geq 0$.

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Monetary policy and wealth effects

The two-step procedure

A monetary policy shock triggers two types of policy response:

- Changes in the nominal interest rate i_t
- Changes in the fiscal backing $\tau_t \equiv - \sum_{j \in o,p} \mu_j T_{j,t}$

To isolate the effect of nominal rates on asset prices, we proceed in two steps

1. Solve for y_t and π_t given $[i_t, \tau_t]$
2. Solve for $[i_t, \tau_t]$ given the interest rate rule.

Aggregate wealth effect

Definition

The aggregate wealth effect corresponds to (minus) the total compensation required for households' initial consumption to be just affordable:

$$\Omega_0 \equiv -\frac{1}{Y} \sum_{j \in \{w,o,p\}} \left(\mathbb{E}_0 \left[\int_0^\infty \frac{\eta_t}{\eta_0} \mu_j C_j dt \right] - \mathbb{E}_0 \left[\int_0^\infty \frac{\eta_t}{\eta_0} \mu_j C_{j,t} dt \right] \right).$$

This corresponds to sum of *Hicksian wealth compensation* in Mas-Colell et al. (1995).

- This motivates our definition of wealth effects

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- This motivates our definition of wealth effects
- We can linearize Ω_0 to obtain

$$\Omega_0 = \int_0^\infty e^{-\rho t} c_t dt.$$

Intertemporal budget constraint

The aggregate intertemporal budget constraint is given by

$$\underbrace{\mathbb{E}_0\left[\int_0^\infty \frac{\eta_t}{\eta_0} C_t dt\right]}_{Q_{C,0}} = D_{G,0} + Q_{E,0} + \underbrace{\mathbb{E}_0\left[\int_0^\infty \frac{\eta_t}{\eta_0}\left(\frac{W_t}{P_t}N_t + T_t\right) dt\right]}_{Q_{H,0}}$$

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The price of the consumption claim is given by

$$q_{C,0} = \frac{C}{Q_C}\int_0^\infty e^{-\rho t} c_t dt - \int_0^\infty e^{-\rho t}(i_t - \pi_t + r_C p_{d,t}).$$

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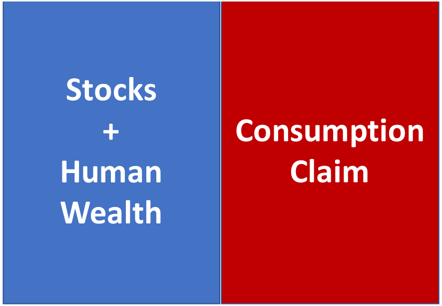
The aggregate wealth effect is given by

$$\Omega_0 = \underbrace{\frac{D_G}{Y} q_{L,0} + \frac{Q_E}{Y} q_{E,0} + \frac{Q_H}{Y} q_{H,0}}_{\text{revaluation of real and financial assets}} + \underbrace{\frac{Q_C}{Y}\int_0^\infty e^{-\rho t}\left(i_t - \pi_t + r_C p_{d,t}\right) dt}_{\text{consumption's discount rate effect}}.$$

Wealth effects in the zero debt economy

Suppose $D_G = 0$, so savers' consumption equals dividends every period



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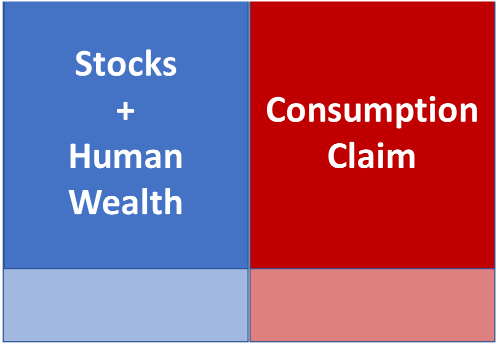

Aggregate wealth effect:

$$\Omega_0 = \int_0^\infty e^{-\rho t} \left[\hat{\Pi}_t + \frac{WN}{PY}(w_t - p_t + n_t) + T_t \right] dt$$

No discount rate effect

- Same duration of assets and liabilities

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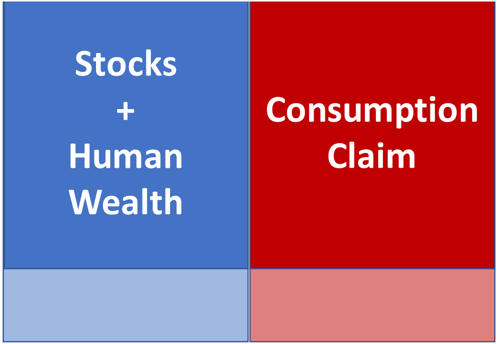

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For an investor who only consumes dividends, Cochrane (2020) says

> *"When the interest rate goes down, it takes more wealth to finance the same consumption stream. The present value of liabilities – consumption – rises just as much as the present value of assets, so on a net basis Bob is not at all better."*

Risk-premium neutrality

Proposition

Suppose the following two conditions hold:

1. *The government uses a consumption tax to neutralize the precautionary motive induced by* $\hat{\lambda}_t$*, that is, consider* τ_t^c *satisfying* $\dot{\hat{\tau}}_t^c = \lambda \left(\frac{C_s}{C_s^*} \right) \hat{\lambda}_t$*, where* $\hat{\tau}_t^c \equiv \log(1 + \tau_t^c)$, $\tau_t^c = \tau_t^{c,*}$
2. *One of the following conditions are satisfied: i)* $\overline{d}_G = 0$*; ii)* $\overline{d}_G > 0$ *and* $\psi_L = \infty$*; iii)* $\overline{d}_G > 0$ *and* $\psi_L = 0$*,*

Then, $[y_t, \pi_t]_0^\infty$ *is independent of* $\hat{\lambda}_t$*.*

Aggregate output and inflation

Proposition

Aggregate output is given by

$$y_t = \underbrace{\sigma^{-1}\hat{y}_{m,t}}_{\text{ISE}} + \underbrace{\chi_\lambda \hat{y}_{\lambda,t}}_{\substack{\text{heterogeneous} \\ \text{beliefs}}} + \underbrace{(\rho - \underline{\omega}) e^{\underline{\omega} t} \Omega_0}_{\substack{\text{GE multiplier} \times \\ \text{aggregate wealth effect}}},$$

where $\int_0^\infty e^{-\rho t} \hat{y}_{k,t} dt = 0$, $\frac{\partial \hat{y}_{k,0}}{\partial i_0} < 0$, *for* $k \in \{m, \lambda\}$.

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Inflation is given by

$$\pi_t = \sigma^{-1}\hat{\pi}_{m,t} + \chi_\lambda \hat{\pi}_{\lambda,t} + \kappa e^{\underline{\omega} t}\Omega_0,$$

where $\frac{\partial \hat{\pi}_{k,t}}{\partial i_0} \geq 0$, *for* $k \in \{m, \lambda\}$.

Determination of aggregate wealth effect

The aggregate wealth effect is given by

$$\Omega_0 \equiv \int_0^\infty e^{-\rho t} \left[(1-\chi_\tau) y_t - \tau_t \right] dt + \overline{d}_G q_{L,0} + \overline{d}_G \int_0^\infty e^{-\rho t} \left(i_t - \pi_t - r_n + r_L p_{d,t} \right) dt,$$

where χ_τ is the cyclicality of tax revenues.

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Proposition

Suppose $\chi_\tau + \frac{\overline{d}_G \kappa}{\rho - \underline{\omega}} > 0$*. Then,* Ω_0 *is a function of* $[i_t, \tau_t]_0^\infty$ *given by*

$$\Omega_0 = \frac{\rho - \underline{\omega}}{(\rho - \underline{\omega})\chi_\tau + \overline{d}_G \kappa}\left[-\int_0^\infty e^{-\rho t}\tau_t dt + \overline{d}_G\left(q_{L,0} + \int_0^\infty e^{-\rho t}(i_t - \hat{\pi}_t - r_n + r_L \hat{\lambda}_t)dt\right)\right],$$

where $\hat{\pi}_t \equiv \sigma^{-1}\hat{\pi}_{m,t} + \chi_\lambda \hat{\pi}_{\lambda,t}$ *is a function of* $[i_t]_0^\infty$.

Implementability condition

Our results so far expressed y_t and π_t in terms of policy variables

- But i_t and τ_t are themselves functions of the monetary shock u_t
- Taylor rule: $i_t = r_n + \phi_\pi \pi_t + u_t$

One can always find the path u_t that delivers a given $[i_t]_0^\infty$ and $\int_0^\infty e^{-\rho t} \tau_t dt$:

$$i_t = \bar{i}_t + \phi_\pi (\pi_t - \overline{\pi}_t),$$

or, equivalently, $u_t = \vartheta e^{-\psi_m t}(i_0 - r_n) + \theta e^{\underline{\omega} t}$, given parameters ϑ and θ.

Quantitative Importance of Wealth Effects

Calibration

For the quantitative exercise, we consider two extensions

- Perpetual youth of savers: control persistence of $\hat{\lambda}_t$
- Workers can borrow a positive amount $\overline{D}_p$
    - Short-term safe debt, long-term risky bonds in extension

Disaster calibration follows Barro (2006)

- Y^* / Y is calibrated to match empirical distribution of disasters
- Risk aversion coefficient: $\sigma = 4 \Rightarrow$ EIS of 0.25
    - Consistent with evidence by Best et. al (2020)

Two main objects to calibrate

- The response of the price of risk to monetary policy ϵ_λ
- The fiscal response to monetary policy

The asset-pricing response to monetary shocks

Consider price of long-term bonds:

$$q_{L,0} = -\int_0^\infty e^{-(\rho+\psi_d)t}(i_t - r_n)dt - \int_0^\infty e^{-(\rho+\psi_d)t} r_L(\sigma c_{s,t} + \epsilon_\lambda(i_t - r_n))dt.$$

Calibrate ϵ_λ to match initial response of 5-year yield on government bonds.

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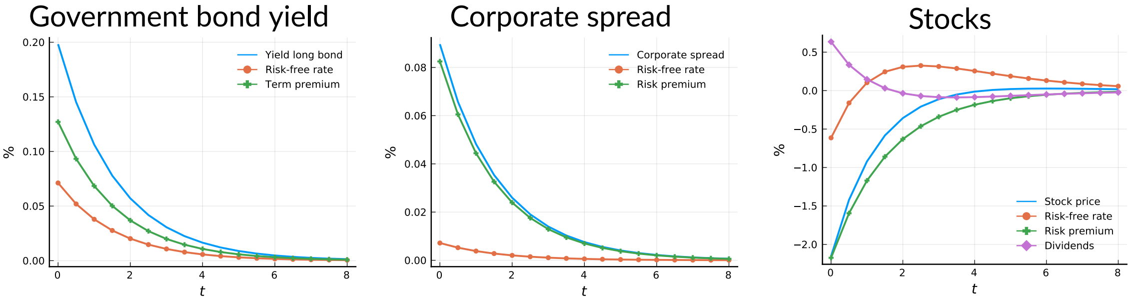

Figure: Asset-pricing response to monetary shocks with heterogeneous beliefs.

The role of heterogeneous beliefs

Heterogeneous beliefs is key for these results

- With homogeneous beliefs, model does not match movements in risk premia
- But model can still match unconditional moments

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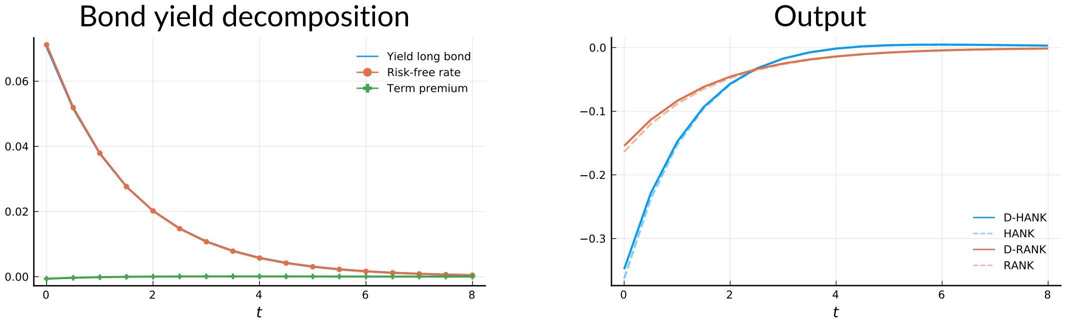


Figure: Long-term bond yields and output for economies with and without risk.

Estimating the fiscal response to monetary policy

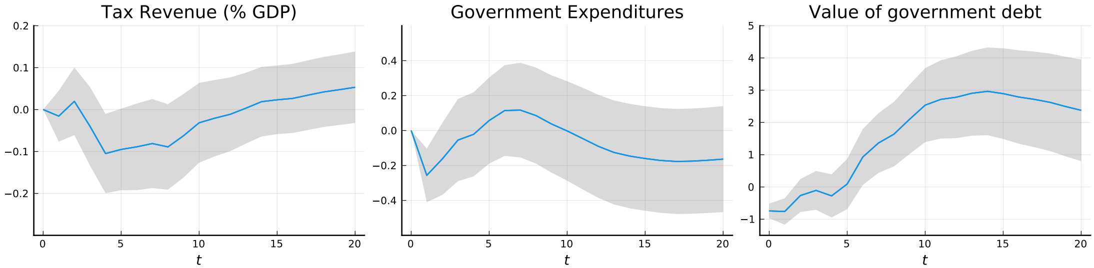
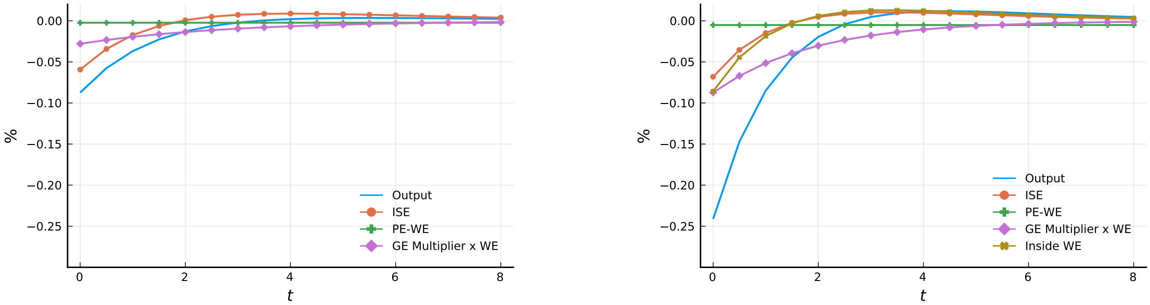


Figure: Estimated fiscal response to a monetary policy shock

	(1) Revenues	(2) Interest Payments	(3) Transfers & Expenditures	(4) Debt in T	(5) Initial Debt	(1) - (2) - (3) + (4) - (5) Residual
Data	-26	68.88	-12.09	2.91	-49.74	30.13
	[-72.89,20.89]	[30.01,107.75]	[-48.74,24.56]	[-12.79,18.62]	[-68.03,-31.46]	[-4.74,65]

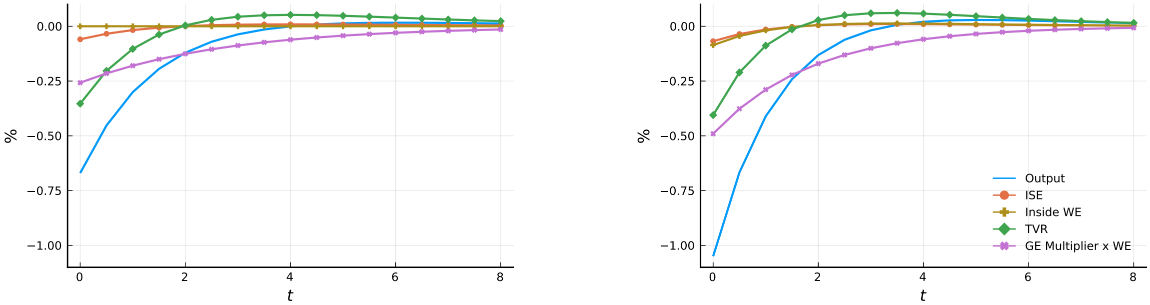
Output response with homogeneous beliefs



(a) Zero workers' debt (b) Positive workers' debt

Figure: **Homogeneous beliefs**

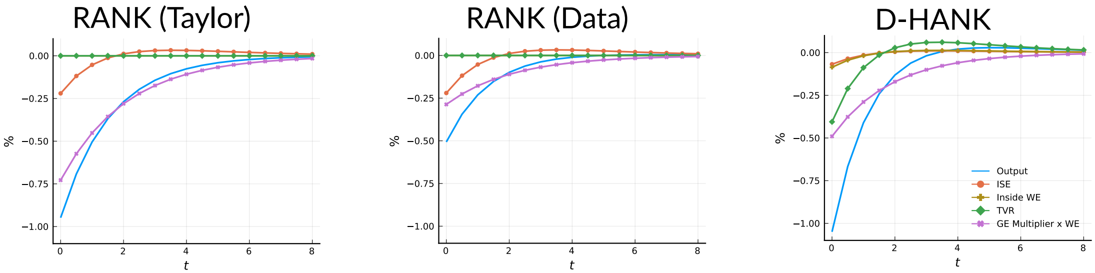
Output response with heterogeneous beliefs



(a) Zero workers' debt (b) Positive workers' debt

Figure: **Heterogeneous beliefs**

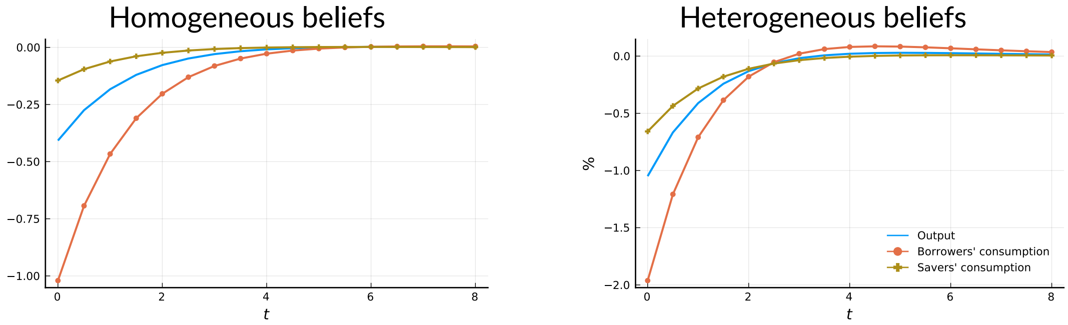
Role of Fiscal Backing



RANK relies on high EIS and strong fiscal backing

- Two panels on the left assume $\sigma = 1$
- Assuming fiscal backing in line with data cuts response in half

Borrowers and savers



Consumption response of borrowers (workers) and savers:

- Model with homogeneous beliefs relies too strongly on the response of borrowers
  - Cloyne et al (2020) estimate relative peak response of 3.6
- Model with heterogeneous beliefs generates relative response in line with data

Risk and Maturity of Household Debt

Extension: Long-term, risky household debt (e.g. mortgages)

Exponentially decaying coupons, rate: ψ_P.

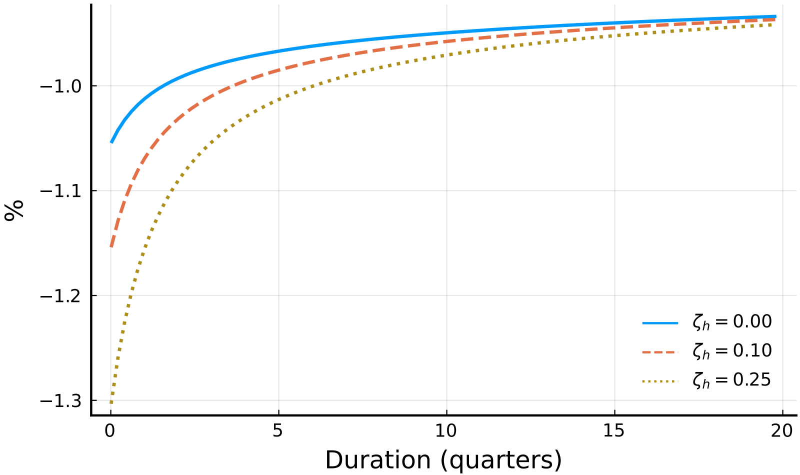
In event of disaster, households **default**. Haircut: ζ_P.

Proposition (Aggregate output with long-term risky debt)

Suppose that $i_t - r_n = e^{-\psi_m t}(i_0 - r_n)$. *Then*

$$y_t = \underbrace{\sigma^{-1}\hat{y}_{m,t}}_{\textit{ISE}} + \underbrace{\chi_d \epsilon_\lambda \hat{y}_{\lambda,t}}_{\substack{\textit{heterogeneous}\\ \textit{beliefs}}} + \underbrace{\frac{\mu_b \chi_r \overline{d}_P}{1-\mu_b} \frac{\psi_P(1+r_P\epsilon_\lambda)}{\rho+\psi_P+\psi_m} \tilde{\psi}_m \hat{y}_t}_{\textit{inside wealth effect}} + \underbrace{(\rho-\underline{\omega})e^{\underline{\omega} t}\Omega_0,}_{\substack{\textit{GE multiplier}\times\\ \textit{aggregate wealth effect}}} \; .$$

Output as a function of duration and haircut ζ_P



Conclusion

This paper: novel framework to study effect of monetary policy through wealth effects.

- We study the role of risk and heterogeneity in portfolios
- Model matches the response of risk premia to monetary shocks.

Risk and heterogeneity matters for monetary policy

- Heterogeneous beliefs substantially amplify output response
- Even with low EIS and matching fiscal response to monetary shocks

Thanks!!!