“Essays on Inequality in Macroeconomics”

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Overview

- Chapter 1: “Wealth Distribution and Monetary Policy”.
- Chapter 2: “Energy Shortages and Aggregate Demand: Output Loss and Unequal Burden from HANK”.
- Chapter 3: “Monetary Policy Betas: Evidence from Italy”.

Chapter 1:
"Wealth Distribution and Monetary Policy"

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Introduction

How does wealth inequality shape the transmission of monetary policy to household consumption?

- In advanced economies wealth is highly concentrated at the top.
- Changes in equity prices have large effects on the wealth distribution.
- Recent evidence shows that interest rate cuts benefit top wealth groups.

- This paper: study the macro implications of wealth dynamics at the top.

This paper

To quantify the macroeconomic impact of different wealth groups I combine:

- The joint distribution of consumption, income, and wealth in the US.
- Quantitative Heterogeneous Agent New Keynesian (HANK) framework.

Show that in a broad class of HANK models:

- Interaction between the wealth distribution and equity prices.
- Shapes cross-sectional and aggregate consumption responses to policy.

Main findings

1. Heterogeneous consumption responses across wealth groups:
   - Households at the tails of the distribution show the largest adjustments.
   - Show micro evidence and use the model to rationalize the empirical findings.
2. Top 10% substantially shape aggregate consumption response.
   - Wealthy households benefit from higher equity prices and capital gains.
   - Have low MPCs out of capital gains but sizable consumption shares.
3. Wealth distribution matter in the propagation of monetary policy (MP):
   - In HANK models changes in the distribution $\Rightarrow$ consumption dynamics.
   - Role of heterogeneous returns, wealth composition and portfolio choices.

Literature

- Quantitative work on MP and household heterogeneity: Kaplan, Moll, and Violante (2018), Gornemann, Kuester, and Nakajima (2021), Lee (2021).
  - Focus on low-liquidity households and top wealth groups.
- Empirical evidence on effects of MP: Amberg, Jansson, Klein, and Rogantini Picco (2022), Andersen, Johannesen, Jorgensen, and Peydró (2021), Slacaleky, Tristani, and Violante (2020), Holm, Paul, and Tischbirek (2021).
  - Income and wealth gains at the top after interest rate cuts.
  - These capital gains substantially outweigh interest income losses.
  - New evidence for the US on consumption response by liquid wealth.

Literature

- Complementary work on the wealthy: Bilbiie, Kanzig, and Surico (2019), Melcangi and Sterk (2020), Luetticke (2021), Kekre and Lenel (2022).
  - Focus on investment effects rather than consumption effects.
- Heterogeneous agents and the macroeconomy: Alves, Kaplan, Moll, and Violante (2020), Debortoli and Galì (2022), Bilbiie (2021).
  - Uncover the macroeconomic implications of wealth dynamics.
  - Interaction of high wealth inequality and changing asset prices.

Model

Households

- Let ψ_t be the cross-sectional distribution over the state space X.
- Markets are incomplete, given states $x = (a, e)$ households solve

$$\max_{(c_t)} \ \mathbb{E}_0 \int_0^\infty e^{-\rho t} u(c_t, n_t) dt,$$

$$\text{s.t. } da_t = (w_t e_t n_t + r_t a_t + d_t - c_t) dt,$$

$$a_t \geq -\phi.$$

- Households trade bonds and accumulate capital.
- Firms' profits D_t are distributed according to $d_t = (e_t / \int_X e_t d\psi_t) D_t$.
- High-income households receive a larger share of profits.

Wage and price setting

- Households supply a continuum of labor services (imperfect substitutes).
- Unions set nominal wages by maximizing the average welfare.

$$mrs_t = w_t \mu_w^{-1}.$$

- Intermediate input producers operate under monopolistic competition.
- Intermediate producers set prices to maximize profits.

$$\pi_t \left(r_t - \frac{\dot{Y}_t}{Y_t} \right) = \dot{\pi}_t + \frac{\epsilon_p}{\Psi_p} (mc_t - \mu_p^{-1}).$$

Financial sector and monetary policy

- The investment fund owns the economy capital stock K_t.
- The fund rents capital to the input producers and invests in new capital.
- Let $\iota_t = I_t/K_t$, the investment problem is

$$V_0 := \max_{\iota_t} \int_0^\infty \left[\exp\left(-\int_0^t r_s ds \right) \left((r_t^k - \iota_t) K_t - \chi_t(\iota_t) \right) \right] dt$$
$$\text{s.t. } \dot{K}_t = (\iota_t - \delta) K_t.$$

- The market value of capital is given by $V_t = q_t K_t$.
- Taylor rule $i_t = r + \phi_\pi \pi_t + \upsilon_t$ with an interest rate policy $\{\upsilon_t\}$.
- Unexpected monetary policy shock

Equilibrium

Definition 1. The equilibrium is (c_t, n_t), $(K_t, N_t, Y_t, I_t, C_t, D_t)$, $(r_t, q_t, w_t, \pi_t, \pi_{w,t})$:

1. Households and unions maximize utility.
2. Firms maximize profits and minimize costs.
3. Markets clear

$$V_t = \int_X a_t d\psi_t,$$
$$N_t = \int_X e_t n_t d\psi_t.$$

4. Monetary policy follows a Taylor rule.
5. The sequence of distributions satisfies aggregate consistency conditions.

Nonlinear system of PDEs solved numerically with global methods.

Parametrization

Calibration

- Two challenges:
  - Match wealth distribution.
  - Jointly match aggregate wealth holdings and average MPC.
- To relax this trade-off:
  - Extraordinary earning states as in Castañeda, Díaz-Giménez, and Ríos-Rull (2003), Poschke, Kaymak, and Leung (2021).
  - Calibrate to financial wealth. Alternatives: heterogeneous discount rates, heterogeneous asset returns, two-assets.
- Functional forms: CRRA utility function, Cobb-Douglas production function, quadratic capital, price, and wage adjustment costs.

Calibration

- Externally calibrated: Preferences, production and New Keynesian block.
- Internally calibrated parameters: $\rho, e_1, e_2, \lambda_1, \lambda_2, \theta_1, \kappa$.
- Targeted moments:
  - Wealth-output ratio, aggregate return to wealth.
  - Gini coefficients of earnings and wealth.
  - Top 0,1%,1% earning shares.
  - Overall fraction of low-liquidity households.
  - Peak of real interest rate response.

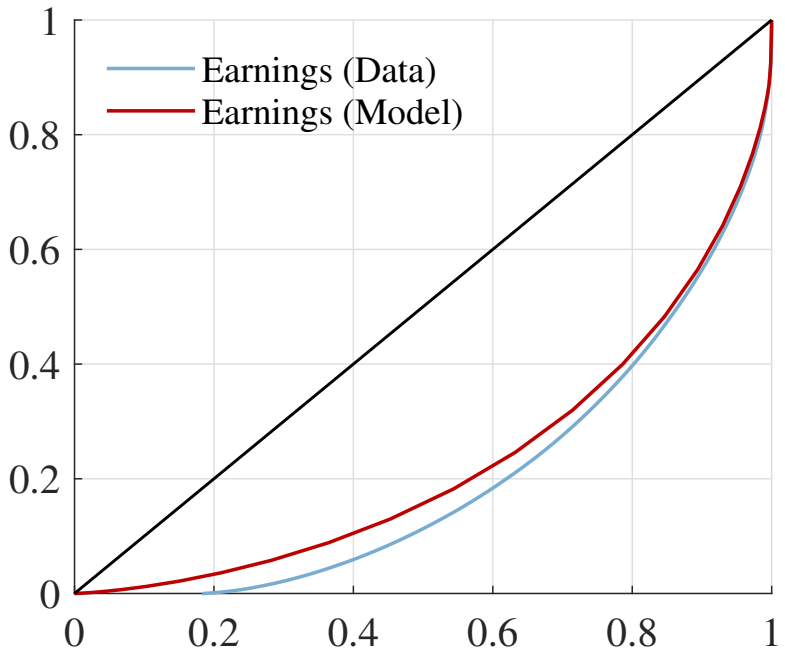
(External calibration) (Income Dynamics)

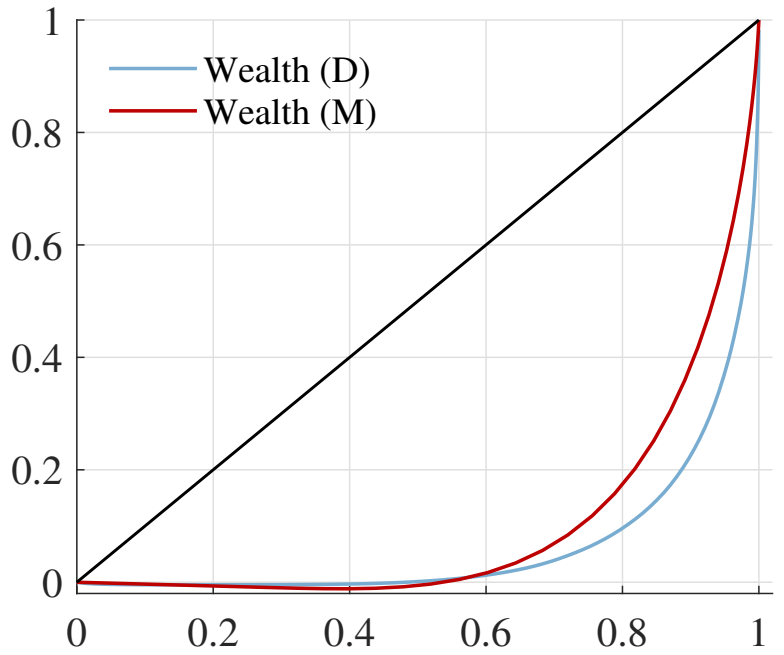
Model fit

Table 1: Targeted statistics

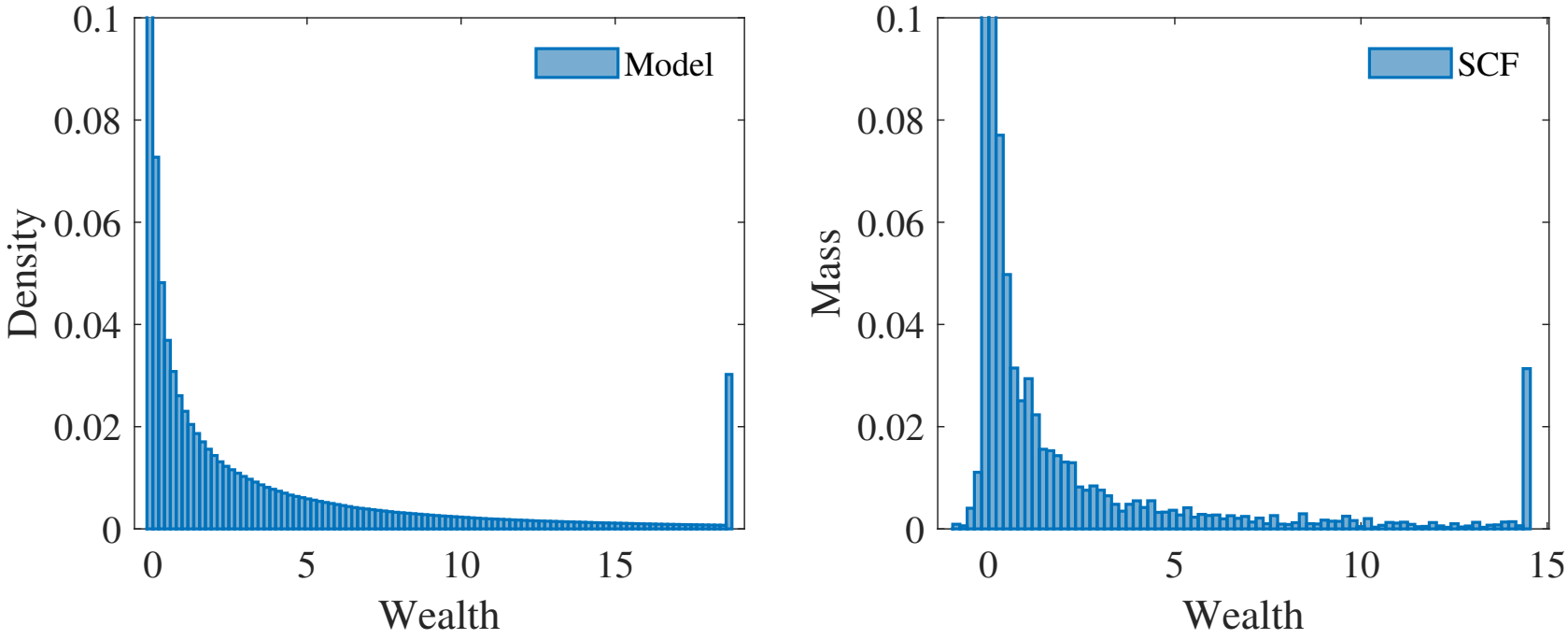
Targeted Statistics	Data	Model
Financial wealth-output ratio	1.42	1.6
Aggregate return on wealth	.065	.074
Fraction with $a = \phi$	0.3	0.32
Gini wealth	0.87	0.81
Gini earnings	0.59	0.54
Top 0.1% earnings share	6	6
Top 1% earnings share	16	15.5

Marginal distributions





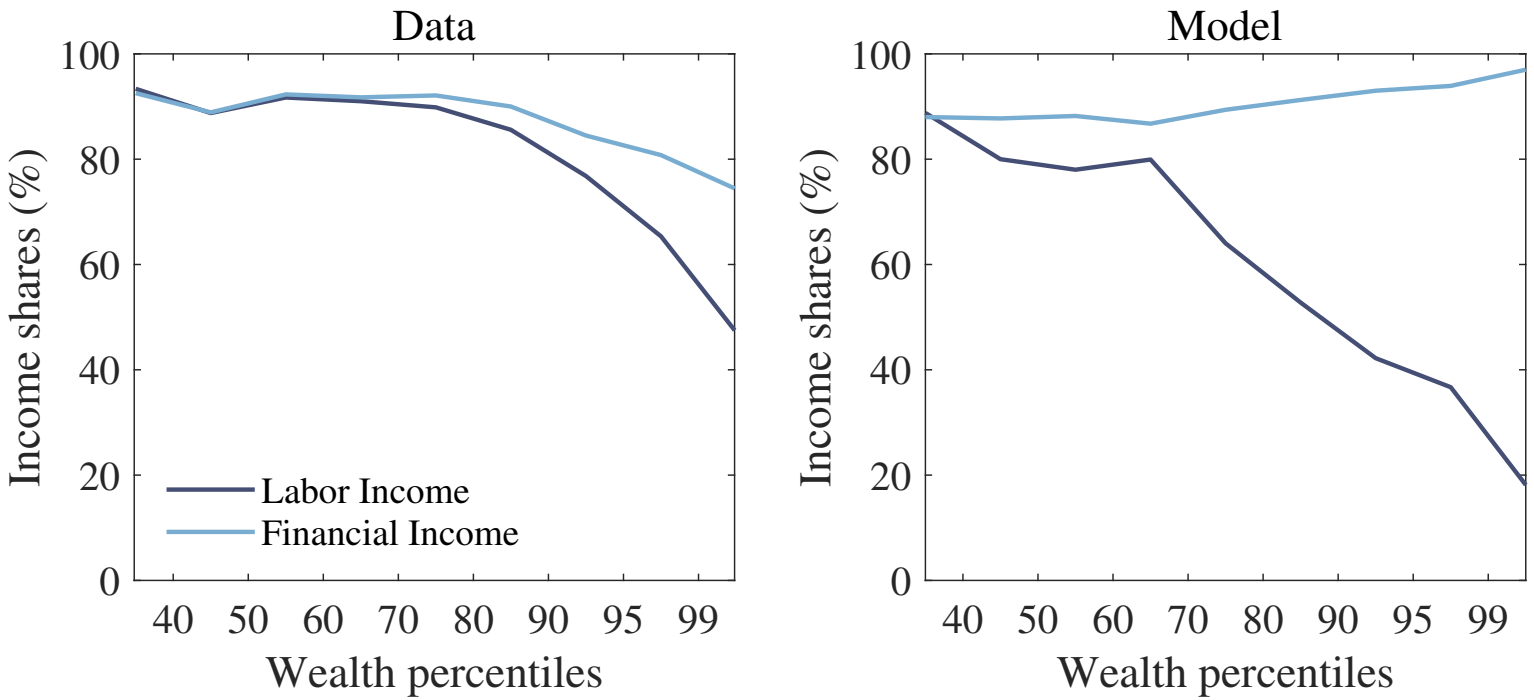
Wealth Distribution



- Wealth to average annual earnings ($68,000), 90th and 95th to 340k, 700k.
- Mean 2.5 (data) and 2.7 (model), median 0.17 and 0.12, 99th pct 34 and 28.

(Top 10)

Income composition



- Income effects of monetary policy depend on income composition.
- The model generates realistic income shares but at the very top.

Marginal propensities to consume

- Average fraction of a transfer consumed in a quarter or in a year
  - Empirical benchmark of 15-25% over one quarter out of a $500 transfer.
  - In the model MPC of 20% over one quarter out of a $500 transfer.
  - Quantitative HANK models at lower bound of empirical estimates.[1]
  - MPC at the top 10% of the wealth distribution is 3%.
  - Wealth distribution matters beyond its implications for MPCs.

[1] Respectively Gornemann, Kuester, and Nakajima (2021), Hagedorn, Manovskii, and Mitman (2019), Kaplan, Moll, and Violante (2018) find 15% (Q), 33% (Y), 12% (Q), 40% (Y), and 16% (Q) 33% (Y). These studies typically set a quarterly empirical benchmark 15%-25% out of transfers between $500 and $1000 (Parker, Souleles, Johnson, and McClelland (2013), Broda and Parker (2014), Fagereng, Holm, and Natvik (2021)).

Empirical Evidence

Data

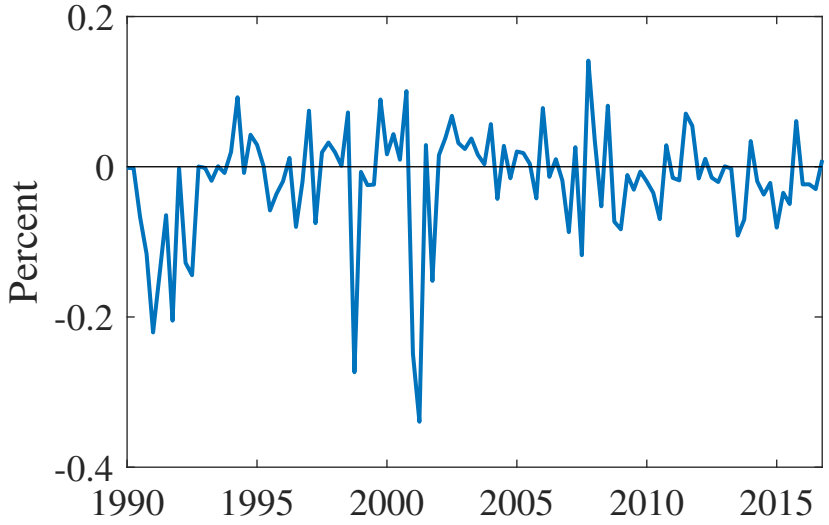
Use the Consumption Expenditure Survey (CE) to measure:

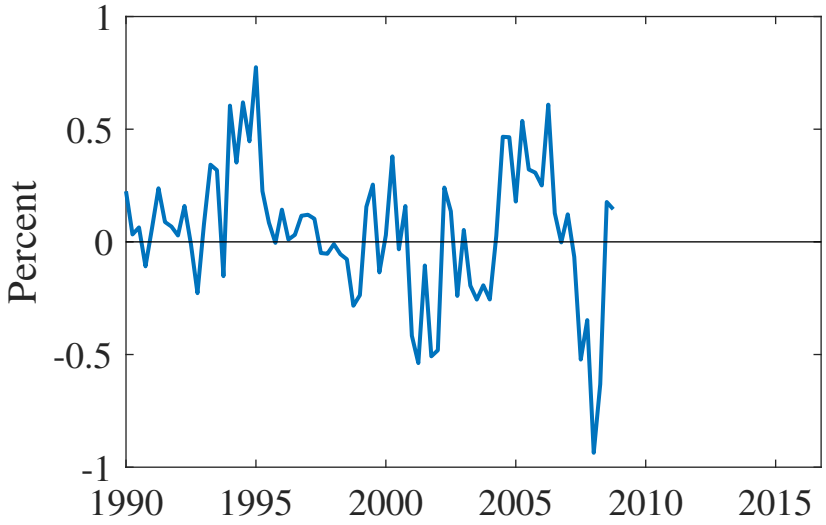
- Nondurable and services consumption.
- Liquid financial wealth (deposits, bonds, stocks).
- Quarterly consumption time series for different wealth groups.
- Jarociński and Karadi (2020), C. Romer and D. Romer (2004).

$$\frac{y_{g,t+h} - y_{g,t-1}}{y_{t-1}} = \alpha_{g,h} + \beta_{g,h} v_t + \sum_{p=1}^{L} \delta_p' x_{g,t-p} + u_{g,t}, \tag{1}$$

- LHS: Quarterly consumption changes. y_t is the CE aggregate consumption.
- v_t is a monetary policy shock. Control for lags of the level $y_{g,t}$ and shocks v_t.

Data

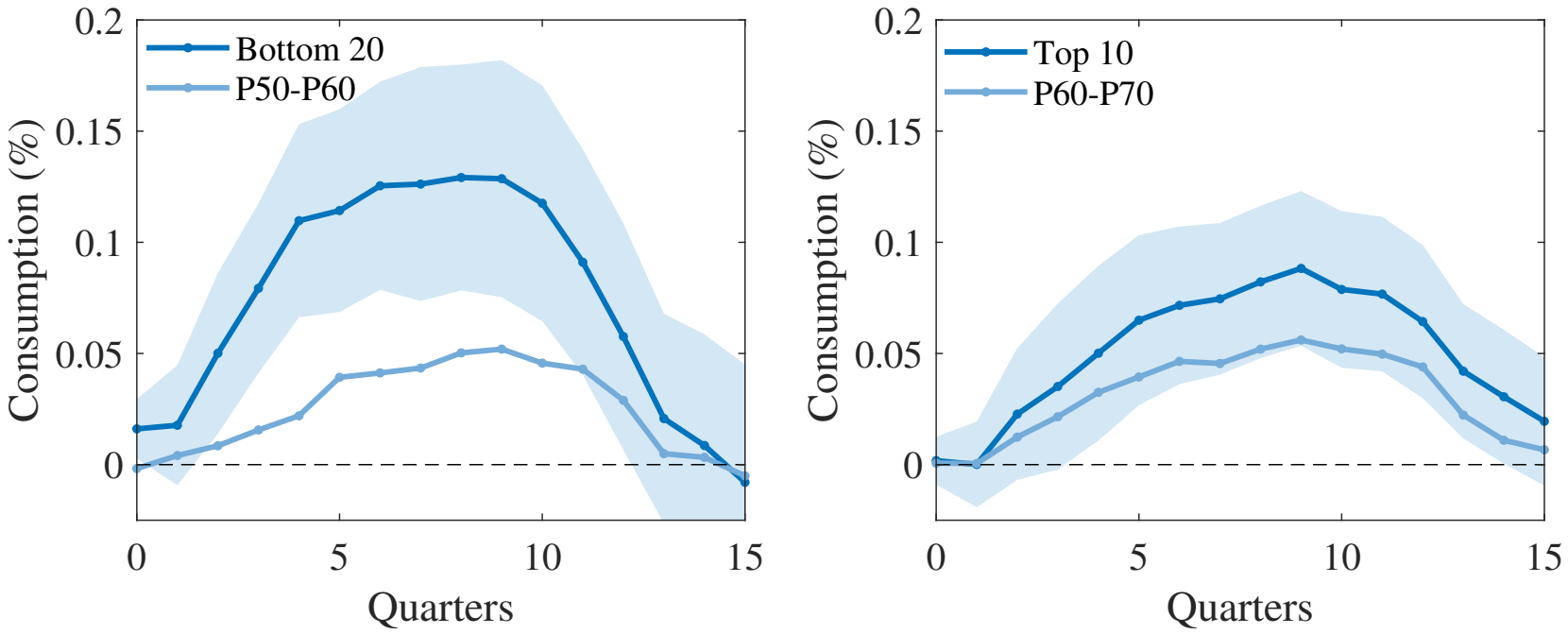




- JK (left) proxy SVAR with high-frequency instruments cleaned for info shocks.
- RR (right) regression of FFR on bank's forecasts of its targets.

(Sample)

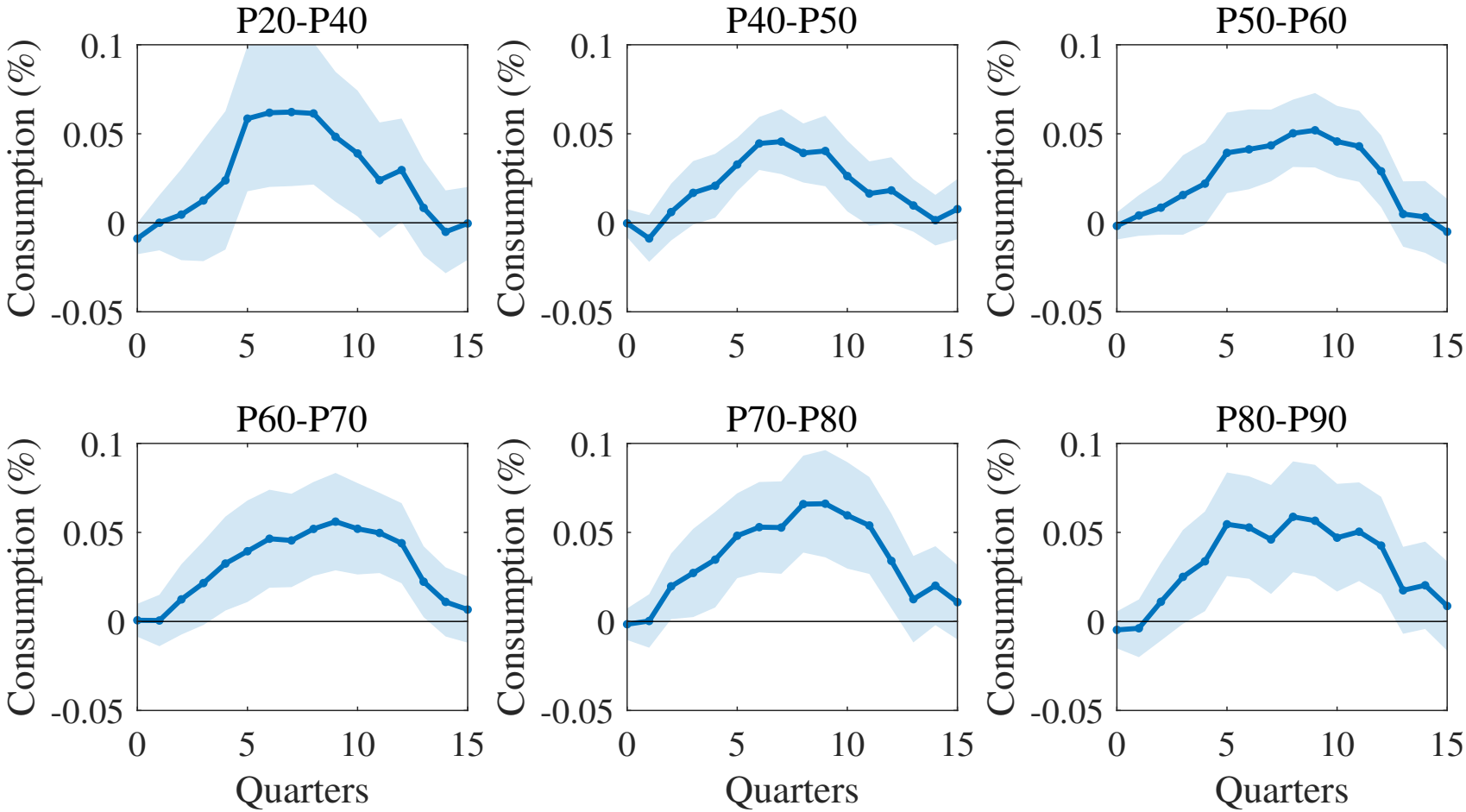
Results



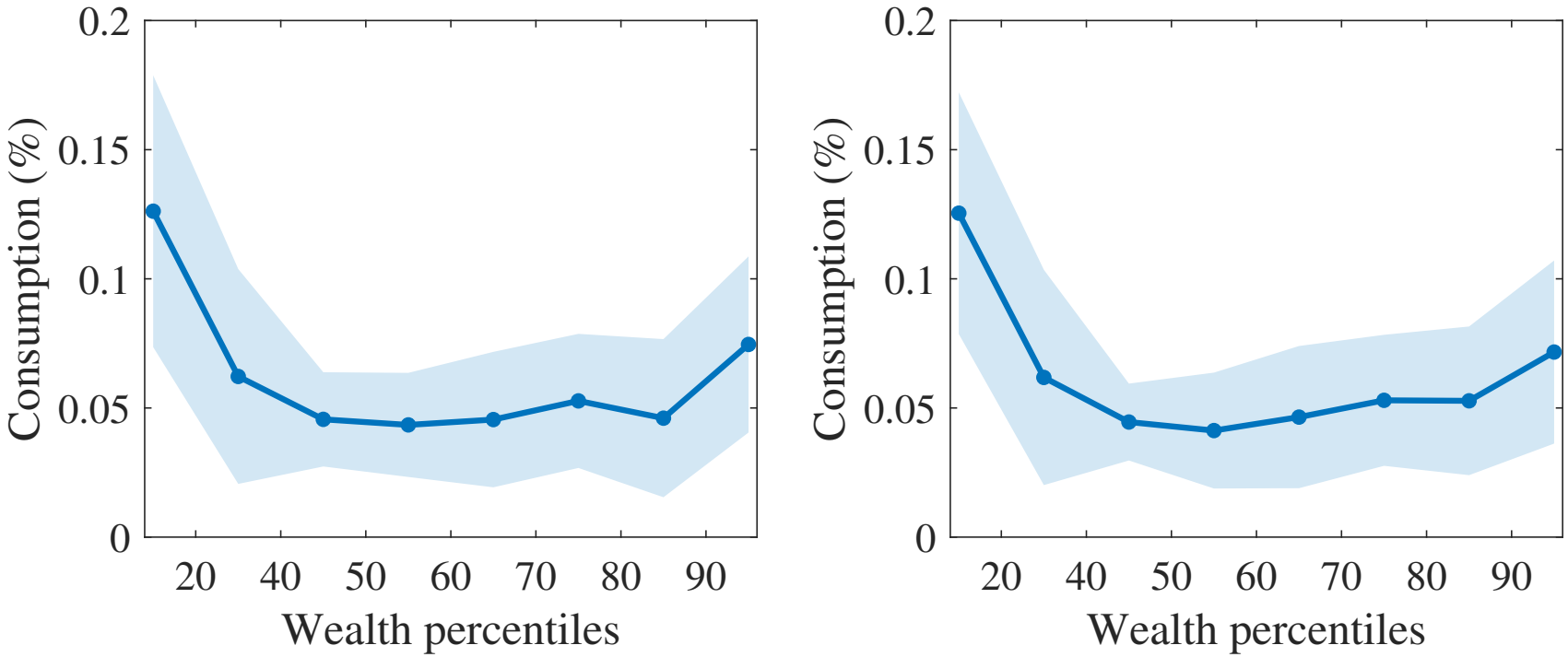
- Responses to an rate cut of 100 basis points and 68% HAC confidence bands.

(RR)

Results


P20-P40
P40-P50
P50-P60
P60-P70
P70-P80
P80-P90
Consumption (%)
0.1
0.05
0
-0.05
0
5
10
15
Quarters

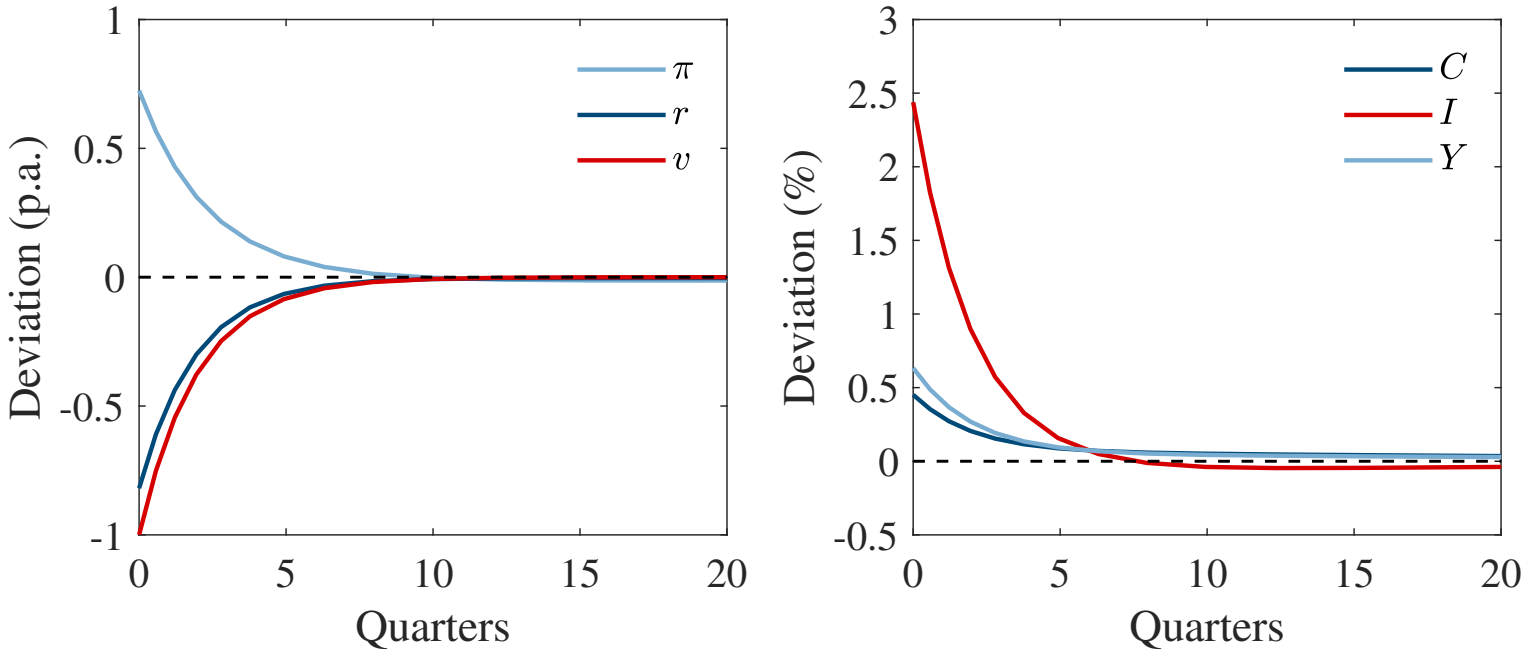
Results



- Cross-sectional effects between 1 and 2 years after the shock.
- The response at the top 10% $>$ 1.5 times the response of any other group.

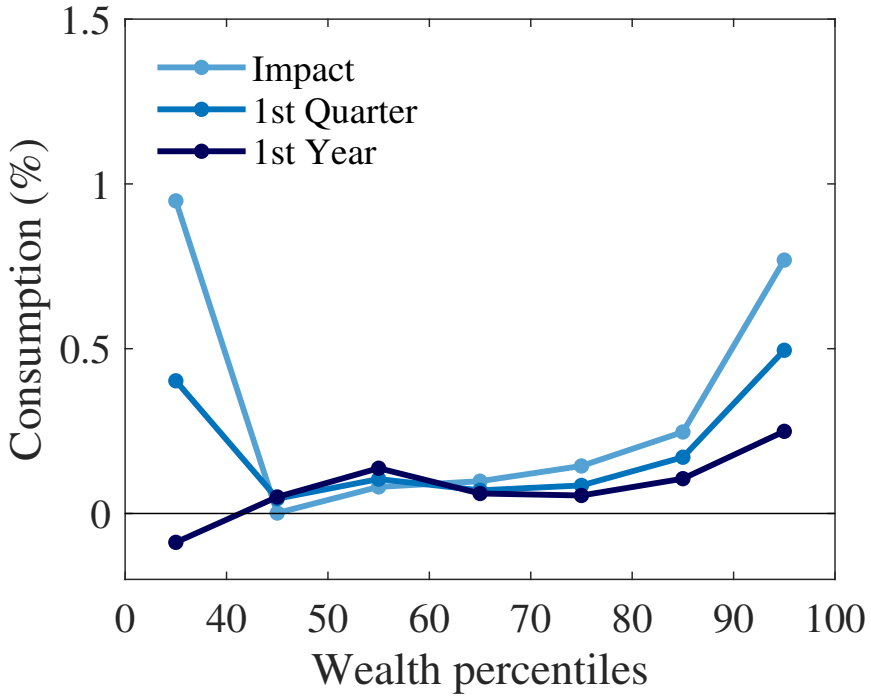
Quantitative Analysis

Aggregate Responses



- IRFs to a 25 basis point or 1% annualized interest rate cut.
- Match volatility and magnitudes. (IRFs)

Consumption Responses



- Households at the tails show the largest consumption responses.
- The model endogenously feature three groups of households.

The role of the wealth distribution

Aggregate consumption is

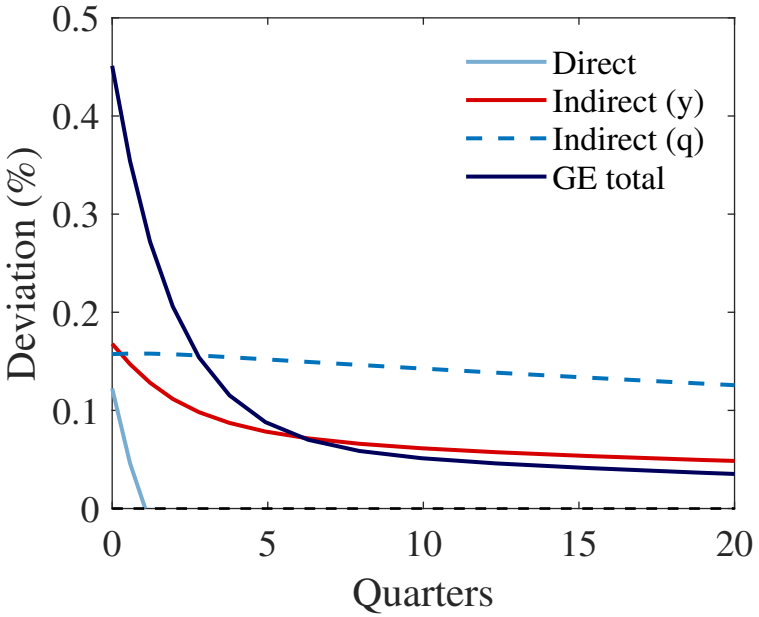
$$C_t(\{r_s, y_s\}, q_0) = \int_X f(x_t; \{r_s, y_s\}_{s \leq t}, q_0) c(x_t; \{r_s, y_s\}_{s \geq t}) dx_t.$$

Totally differentiating delivers

$$dC_t = \int_0^\infty \frac{\partial C_t}{\partial r_s} dr_s ds + \int_0^\infty \frac{\partial C_t}{\partial y_s} dy_s ds + \frac{\partial C_t}{\partial q_0} dq_0.$$

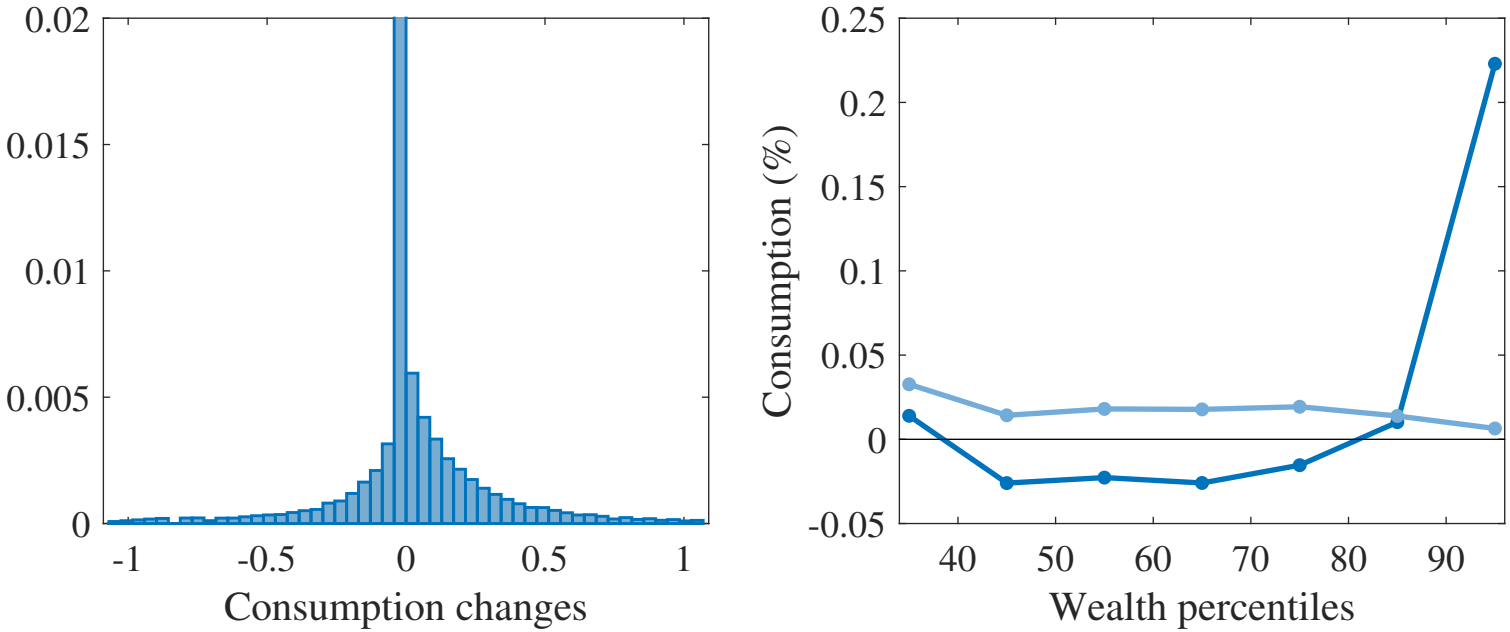
- Initial density f_0 has a first order impact on aggregate consumption.
- f_t is the density function of individual states $x_t \in X$.
- c_t the household consumption decisions, q_0 the equity price at $t = 0$.

The role of the wealth distribution



- The interaction between f_t and q_t accounts for $> 30\%$ of aggregate response.
- Over time $\uparrow a_t$ and $\downarrow r_t$ offset each other and labor market effects dominate.

The role of the wealth distribution



- Higher equity prices benefit sellers and make capital accumulation costly.
- Income effects are redistributive, wealth effects raise consumption at the top.

Heterogeneous returns

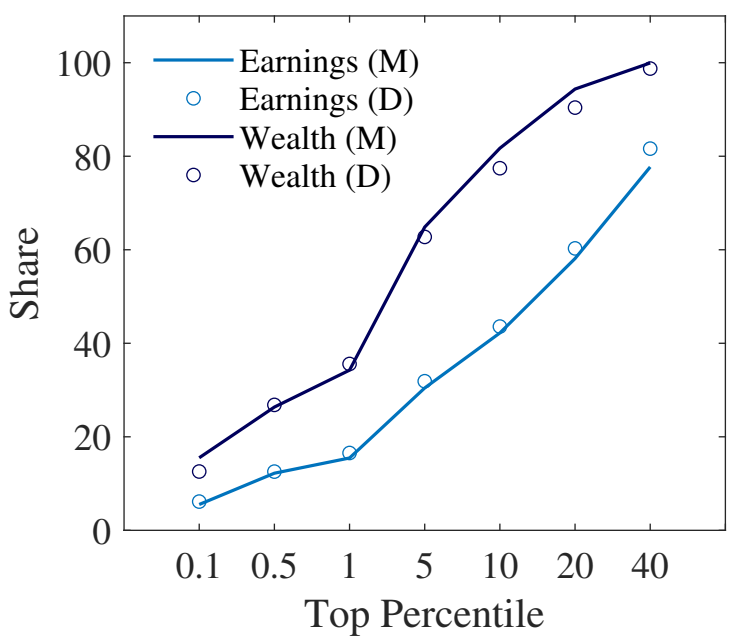
- Supply and policy blocks of the model are the same as in the baseline.
- Asset returns $r_t^a := r_t z_t$ where z_t is a continuous time markov process.
- Households switch according to Poisson arrival rate λ_z and transition matrix

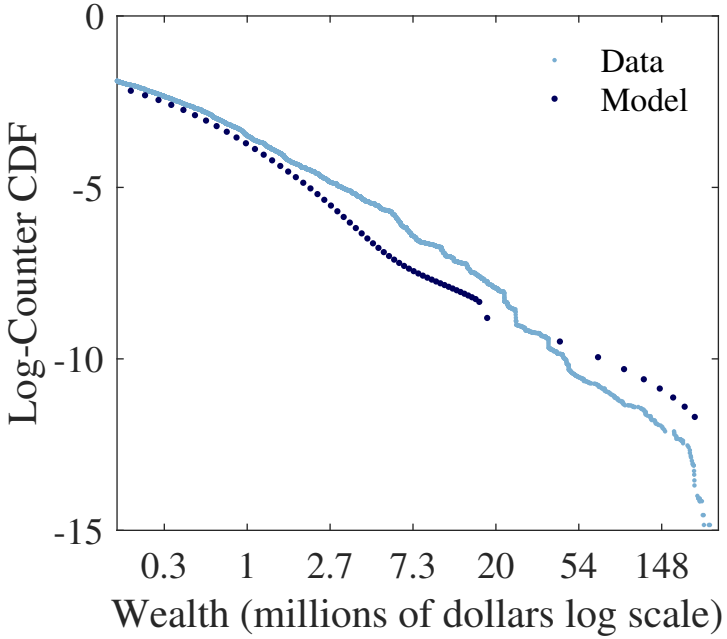
$$T_z = \begin{bmatrix} p_1 & 1 - p_1 - p_{\text{top}} & p_{\text{top}} \\ 1 - p_2 - p_{\text{top}} & p_2 & p_{\text{top}} \\ 0 & 1 - p_3 & p_3 \end{bmatrix}.$$

- The process is persistent and the implied returns are close to 1%,3%, and 7%.
- The model endogenously generates increasing returns to wealth.

(Return cross-section)

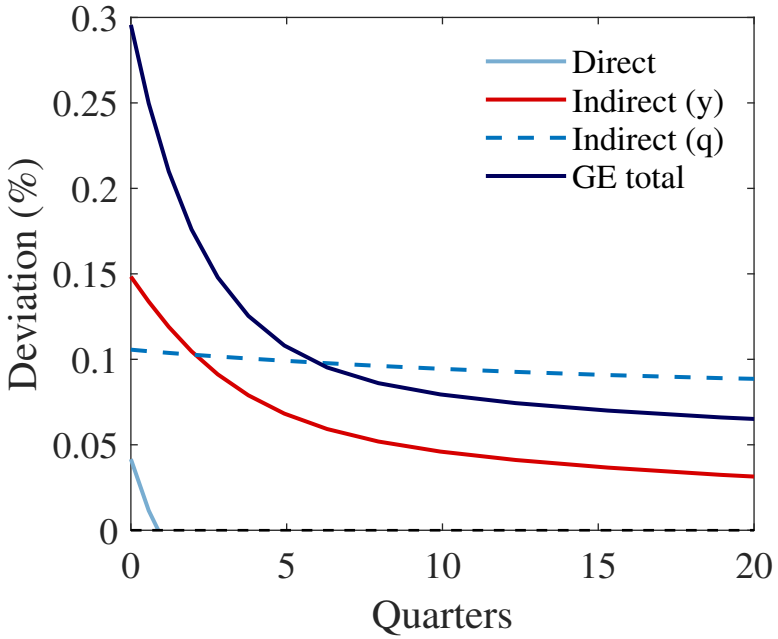
Heterogeneous returns





- The HANK model matches top wealth shares.
- The model fits well the Pareto right tail of the wealth distribution.

Heterogeneous returns



- The direct effect explains around 15% of aggregate consumption response.
- Low-return households tend to frontload consumption expenditures.
- Households in the top 10% instead have $r_t^a > \rho$.

Two-asset model

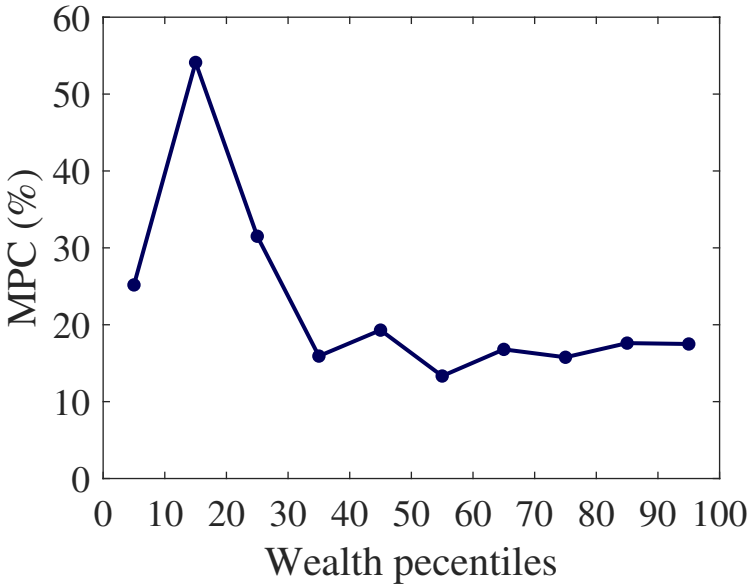
- Survival risk η with average lifespan of 45 years.
- Illiquid "Investment asset" a_t and liquid "Consumption asset" b_t.
- Borrowing wedge κ_b and constriants $a_t \geq 0$ and $b_t \geq -\phi$.
- Household budget:

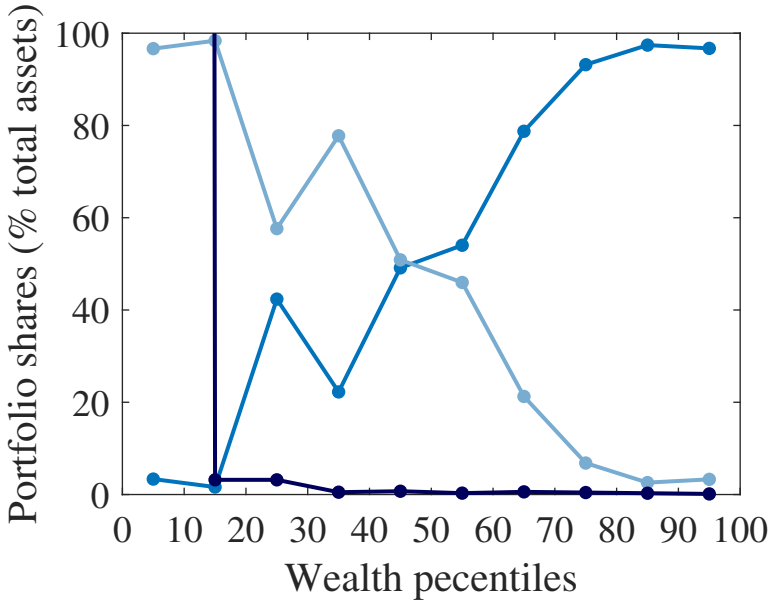
$$db_t = ((1-\omega)w_t e_t n_t + d_t^e + r_t^b b_t - d_t - \chi(d_t, a_t) - c_t)dt,$$
$$da_t = (\omega w_t e_t n_t + r_t^a a_t + d_t)dt.$$

- Convex adjustment costs:

$$\chi(d_t, a_t) := \chi_0 |d_t| + \frac{\chi_1}{2}\left(\frac{d_t}{a_t}\right)^2 a_t.$$

Portfolio choices

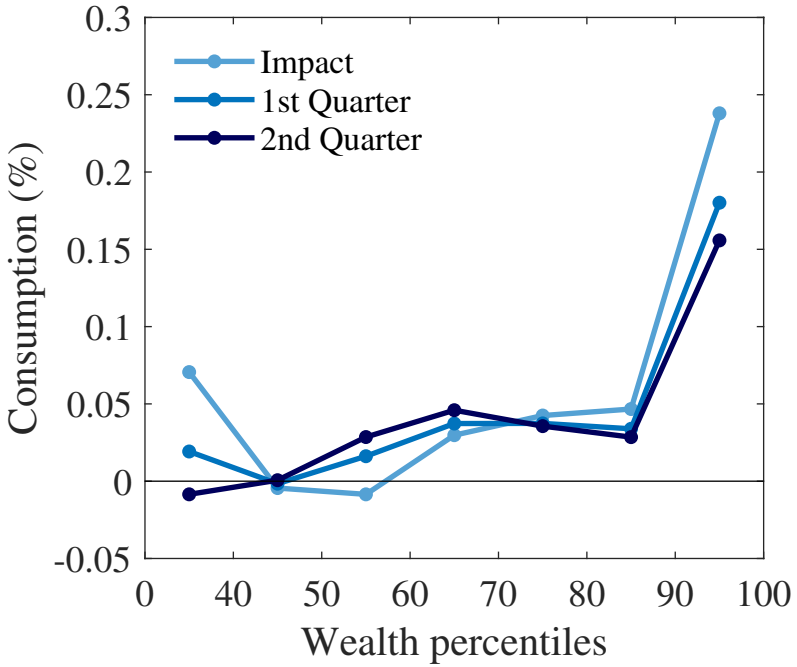


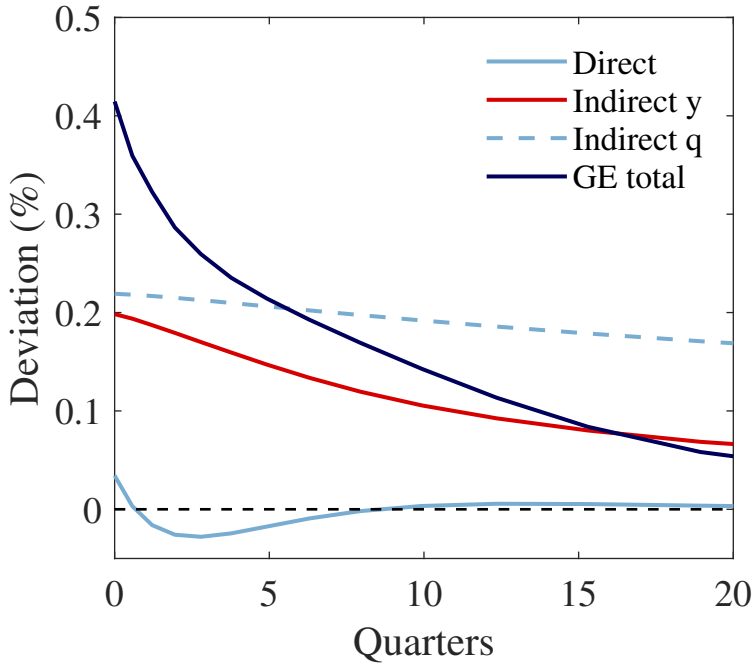


- The MPCs remain sizable throughout the wealth distribution.
- The portfolio shares approximate well those in the SCF microdata.

(Wealth composition SCF)

Portfolio choices





- The model features relatively large consumption adjustments at the tails.
- Wealthy households with few liquid assets $\Rightarrow$ responses of middle-class.
- Households at the top hold few liquid assets reducing direct effect.

Conclusion

Main messages:

- Wealth concentration at the top has macroeconomic implications:
- Top wealth groups have higher exposure to equity prices.
- Changes in the right tail of the wealth distribution shape consumption.
- Inequality $\Rightarrow$ concentration of the effects of MP at the tails of the distribution.

Chapter 2:
"Energy Shortages and Aggregate Demand: Output Loss and Unequal Burden from HANK"

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Introduction

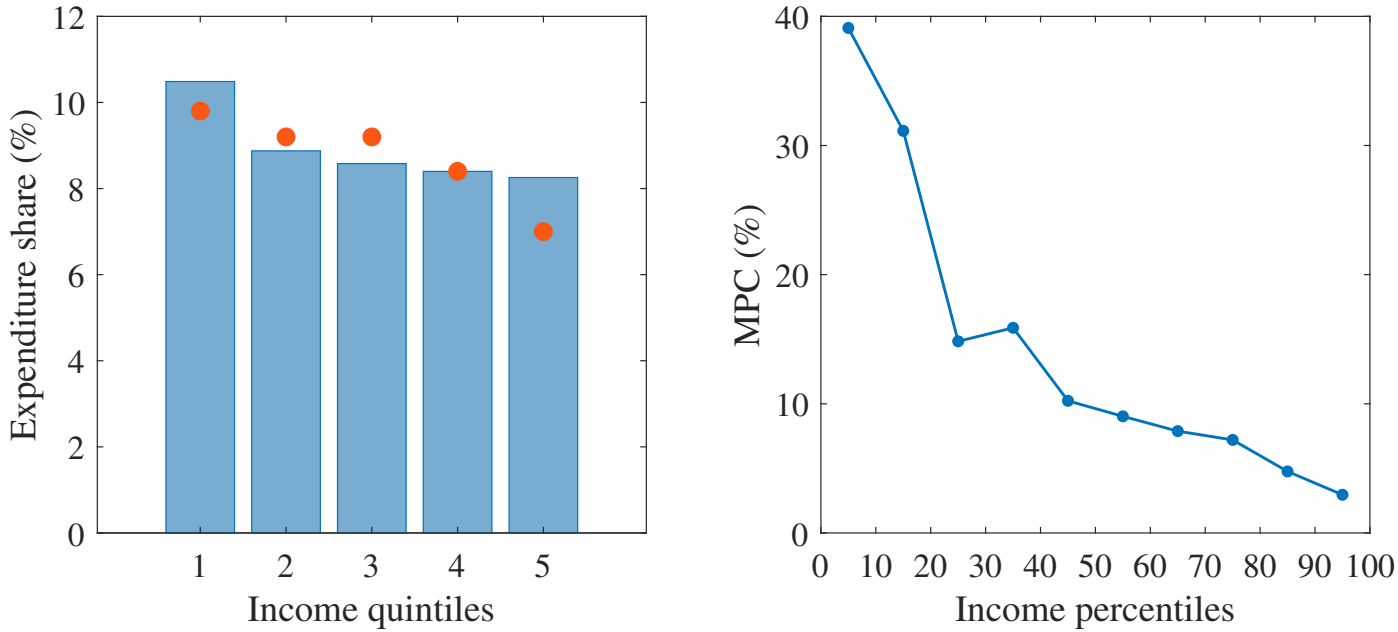
What are the macroeconomic effects of large energy shocks?

- Complete shut down of energy imports from Russia for Italy/Germany.
- Existing literature on energy shocks miss two key elements
  - Size: -10% of national energy consumption (gas, oil, coal).
  - Heterogeneity: Consumption behavior and income exposure.
- Study macroeconomic and distributional effects of large energy shocks.
- Policy implications?

Main findings

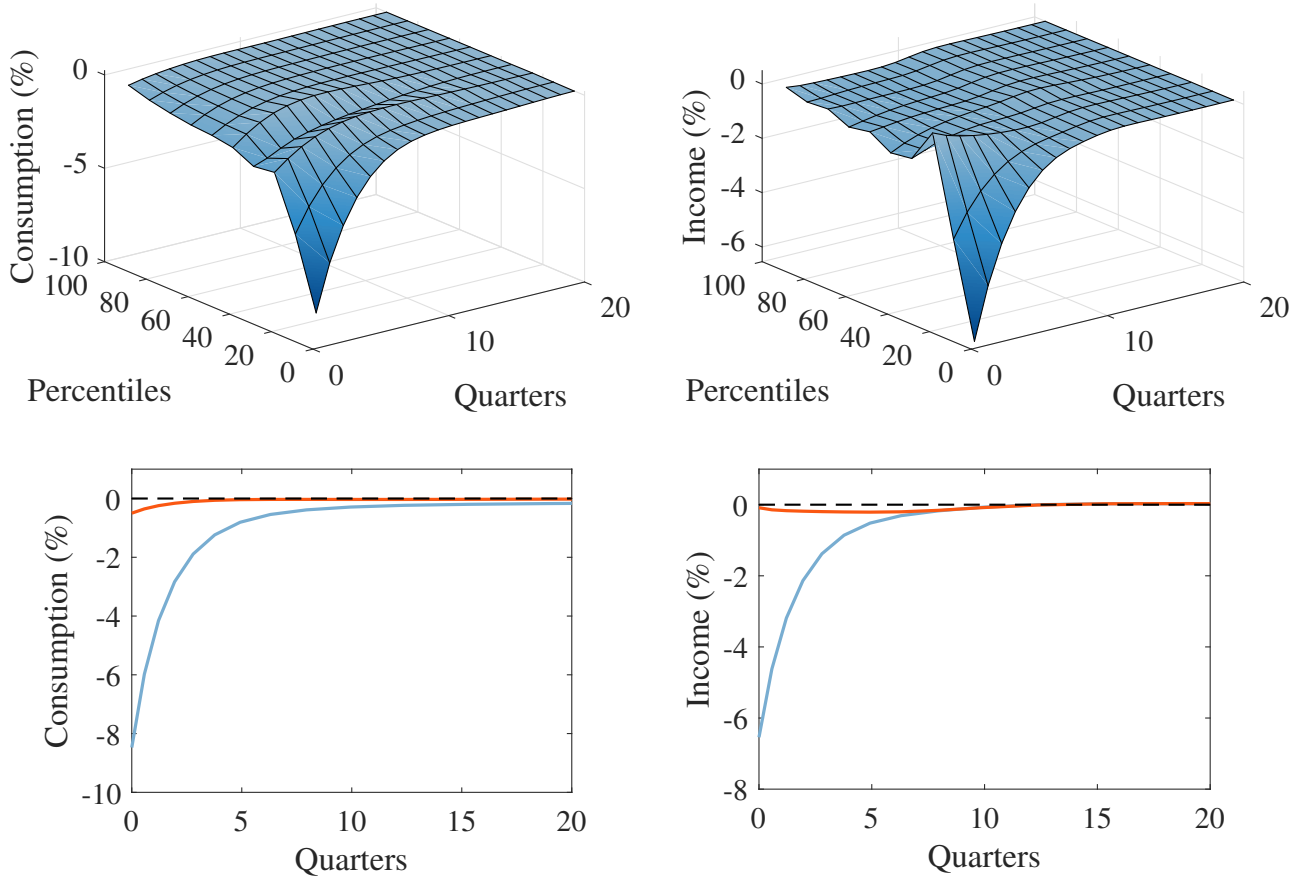
- Low-income households bear the heaviest burden:
  - More exposed to direct and indirect effects.
  - High MPCs amplify the consumption response.
  - Aggregate loss is closely linked to the unequal effects.
- Explore several conservative scenarios energy demand elasticity.
- Policy response:
  - Fiscal policy can mitigate the aggregate demand amplification.
  - If targeted $\Rightarrow$ no trade-offs between output and inflation.
- Even more in the paper (monetary policy, dynamic effects)!

HANK model with energy



- Endogenous energy demand by firms/households and exogenous supply.
- Non-homothetic demand.
- Heterogeneous marginal propensity to consume.

Energy shortages and aggregate demand



- Output loss: 1%, energy bills 20%, labor market 40%, profits/interests 40%.

Energy shortages and aggregate demand

GNI Loss	$\sigma = 0.1$	$\sigma = 0.07$	$\sigma = 0.2$	Fossil gas only
HANK model	1.5%	2%	0.8%	3.4%
CES function	0.6%	0.8%	0.5%	2.3%

- Vast literature on energy (fossil fuels) demand elasticities:
  - Average short-run elasticity for households 0.21, for industry 0.16.

Conclusions

- Substantial amplification through aggregate demand channels.
- Aggreate loss is linked to the unequal effects.
- Substitution/saving margins are very important.

Policy implications:

- Monetary policy is too broad.
- Fiscal transfers can provide social insurance to most exposed households:
  - Lump-sum $\Rightarrow$ do not change relative prices and substitution incentives.
  - Targeted $\Rightarrow$ more effective and do not generate additional inflation.

Chapter 3:
"Monetary Policy Betas: Evidence from Italy"

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Introduction

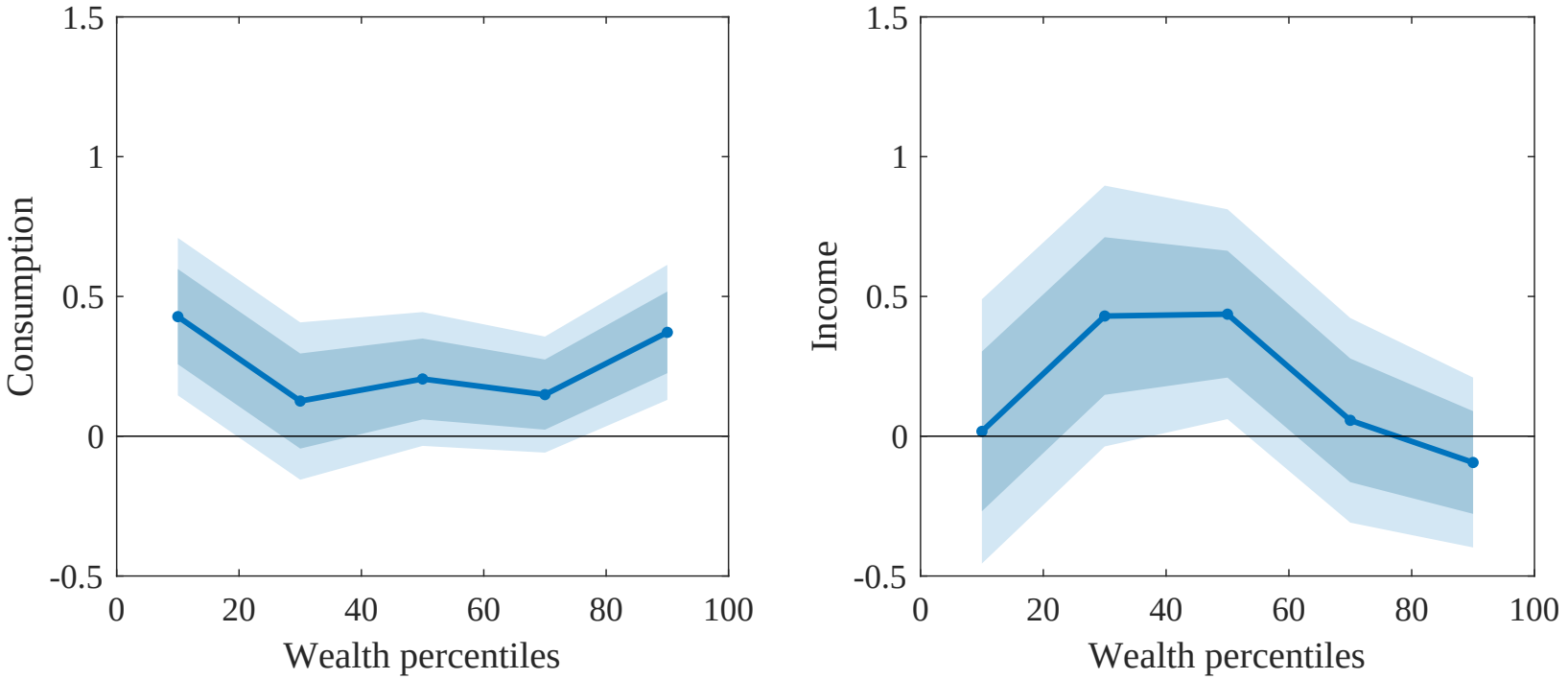
Contributions:

- New evidence on consumption and income responses across wealth groups.
- Empirical assessment of the transmission channels of monetary policy.

Methods:

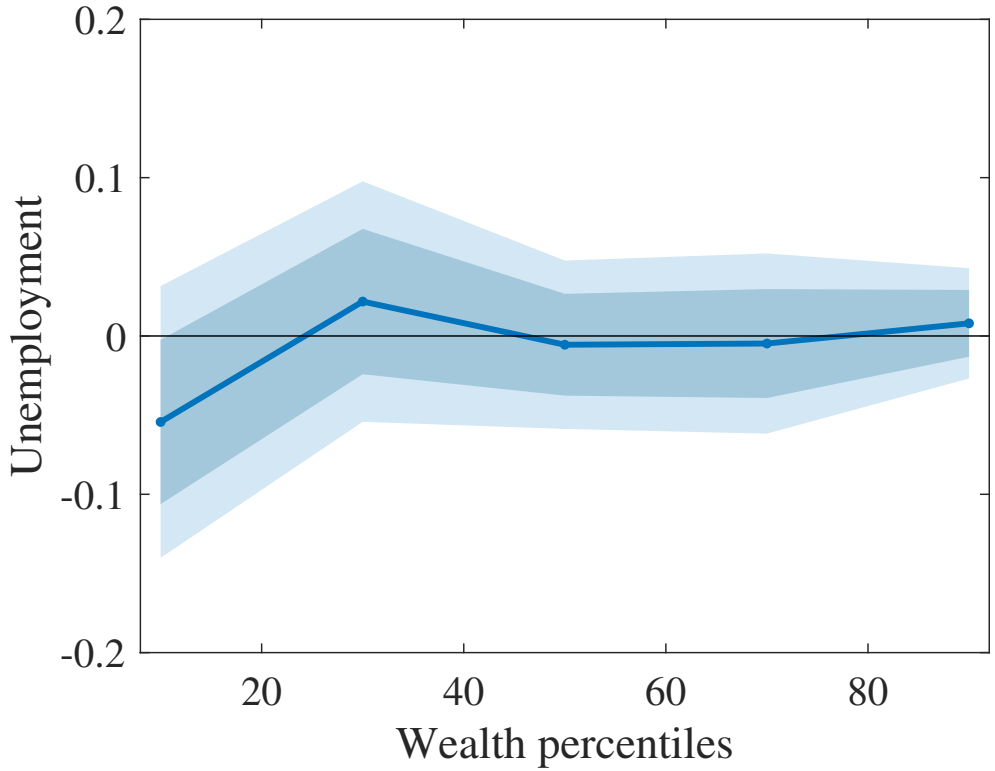
- Construct a time series of monetary shocks with high-frequency approach.
- Validate the series using a SVAR with external instruments (SVAR-IV).
- Household panel data on consumption, income, and wealth.
- Local projections with instrumental variables (LP-IV).

Empirical results



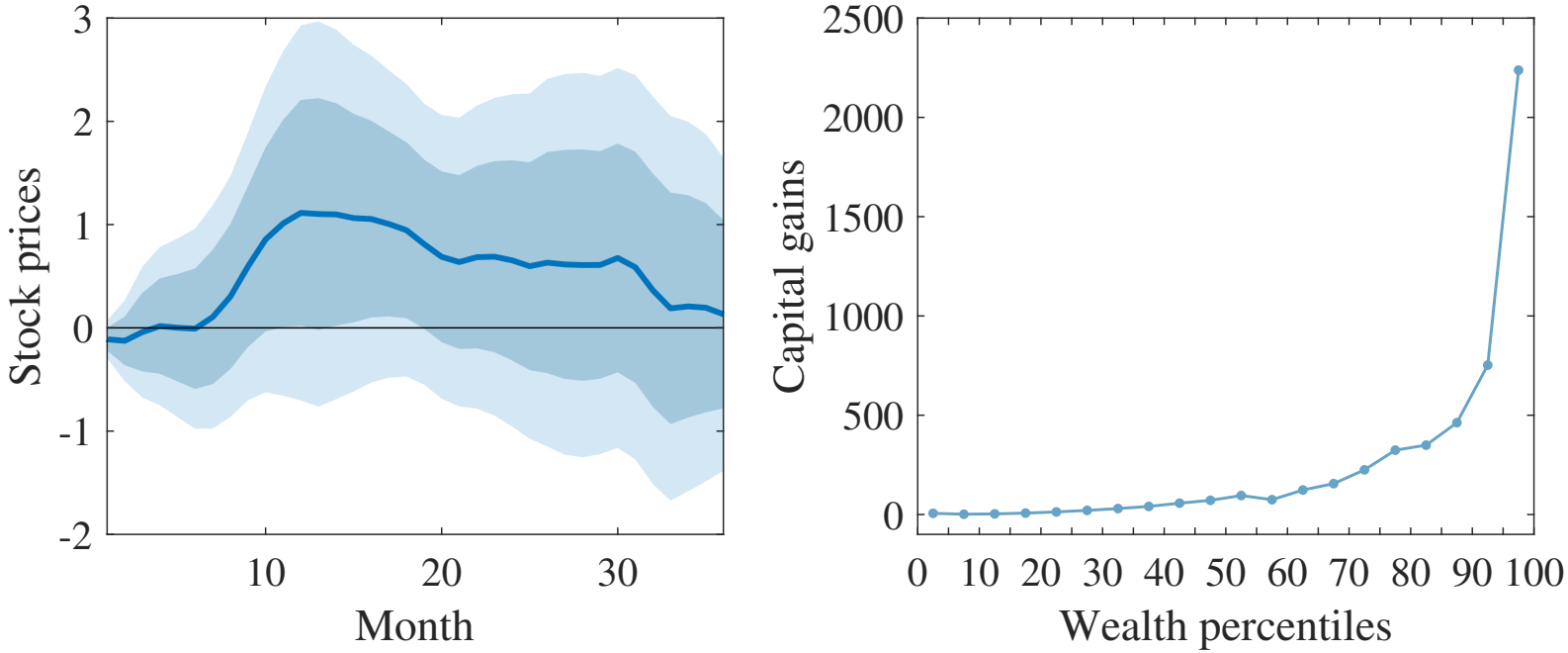
- Impulse response functions to a 25 basis points interest rate cut.
- Consumption increase by 0.42% (bottom), 0.2% (median), 0.37% (top).

Empirical results



- Estimate a simple linear probability model.
- Households at the bottom 20% are less likely to be unemployed.

Empirical results



- Estimate the stock market response to monetary policy (FTSE MIB).
- Compute capital gains from SHIW equity holdings.

Conclusions

Main messages:

- Heterogeneous income and consumption responses to monetary policy shocks.
- The responses are broadly consistent with predictions of HANK models.

Thank you!

Appendix

External calibration

Parameter	Description	Value	Source
γ	CRRA/Inverse IES	1	External
ν	Inverse Frisch elasticity	1	External
ϕ	Borrowing limit	0.5	External
λ_e	Arrival rate normal states	1	External
ν_e	Mean reversion coeff.	0.0263	External
σ_e	S. d. of innovations	0.2	External
θ	Capital elasticity	0.33	External
δ	Depreciation rate (p.a.)	5%	External
Ψ_p	Adjustment cost	100	External
ϵ_p, ϵ_w	Elasticities of substitution	10	External
ϕ_π	Taylor coeff.	1.25	External

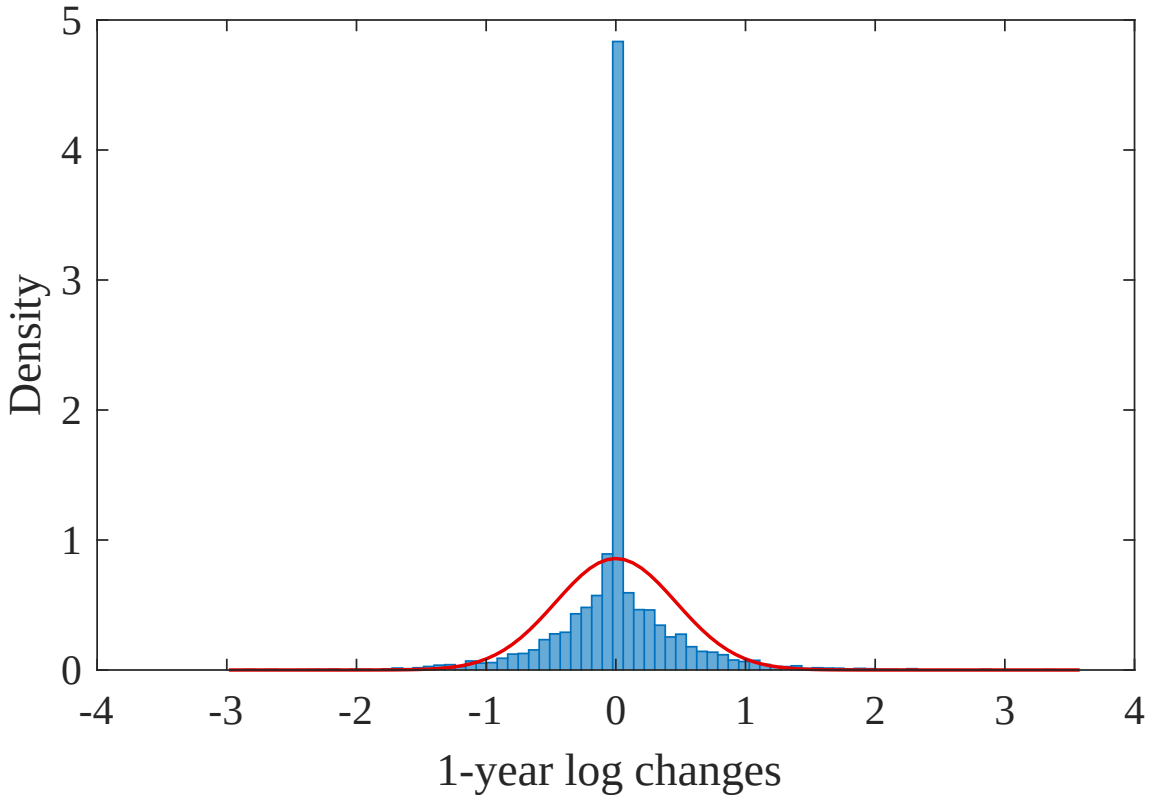
(back)

Income dynamics

Labor income risk e_t follows a Poisson process:

- Households switch between normal states
  - Arrival rate λ_e, conditional distribution F_e, stationary distribution ϕ_e.
  - F_e is characterized by a stochastic transition matrix.
  - This matrix follows from an AR(1) process with parameters $1 - \nu_e, \sigma_e$.
- Jumps from normal states to extraordinary states e_1, e_2
  - Arrival rate λ_1 and transition probabilities θ_1, θ_2.
  - Switch back to normal at rate λ_2 and draw a new state from ϕ_e.
- Calibrated process:
  - Top states e_1, e_2 are 15,55 times the average of the process.
  - Only 0.2%,0.1% of the households are in these states.

Income dynamics



- The estimated kurtosis is around 9 in the model and 17.8 in the data.

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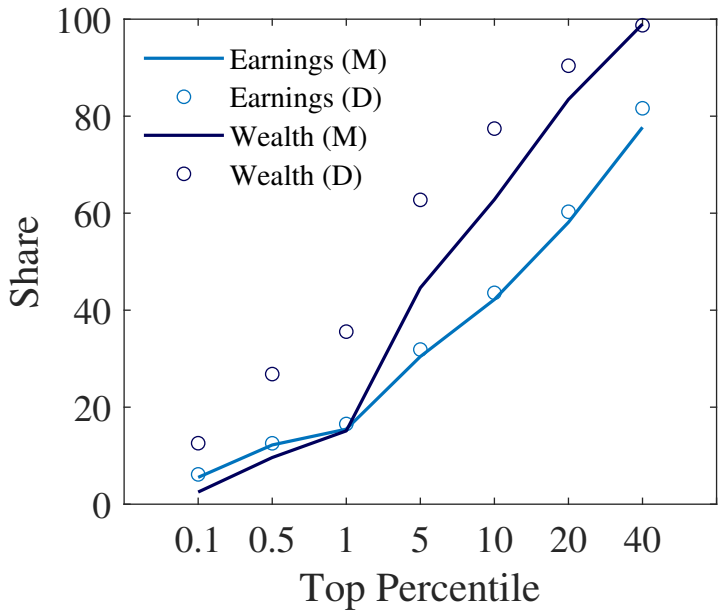
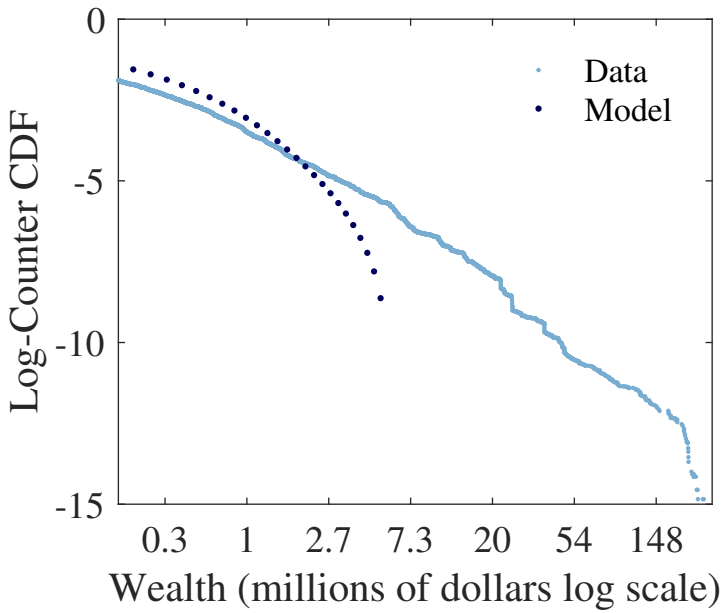
Top shares and Pareto tail





- Model fits well the wealth distribution up to 99th wealth percentile.

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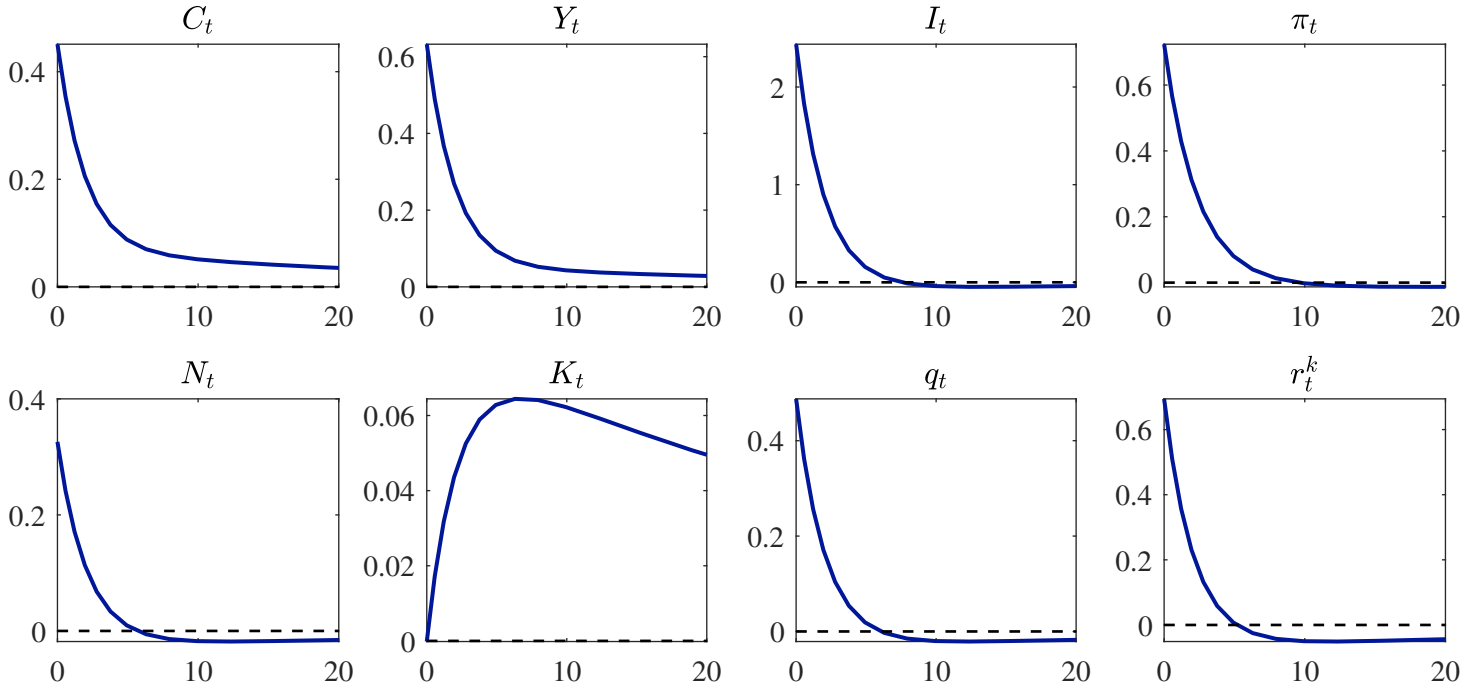
Wealth percentiles

Wealth statistics	Data	Model	Wealth statistics	Data	Model
Mean wealth	2.5	2.7	90th percentile	5	8
Median wealth	0.17	0.12	95th percentile	10	13
75th percentile	1.3	2.3	99th percentile	34	28

IRFs to monetary policy



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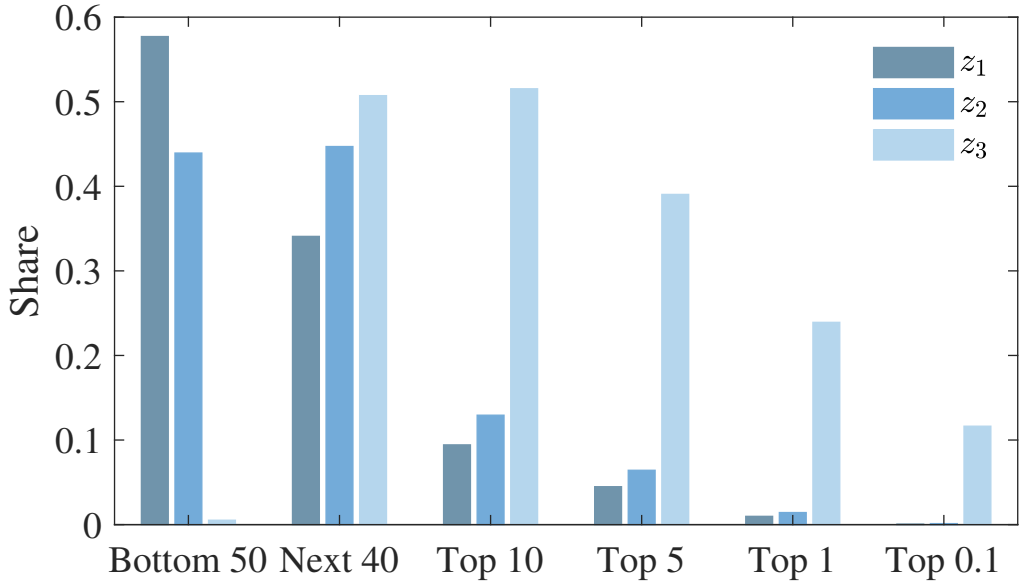
Heterogeneous returns



- Top investors are equally distributed between the top 10% and middle-class.
- Households with low asset return are more frequent in the bottom 50%.

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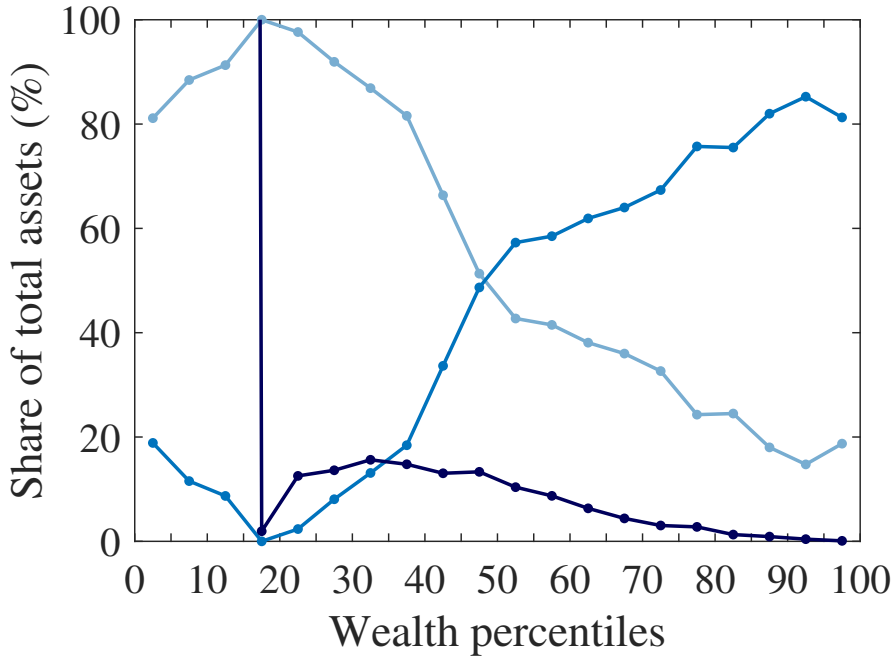
Wealth composition



- Average portfolio shares of liquid assets (light blue line), public equity (blue line), and short term debt (dark blue line).

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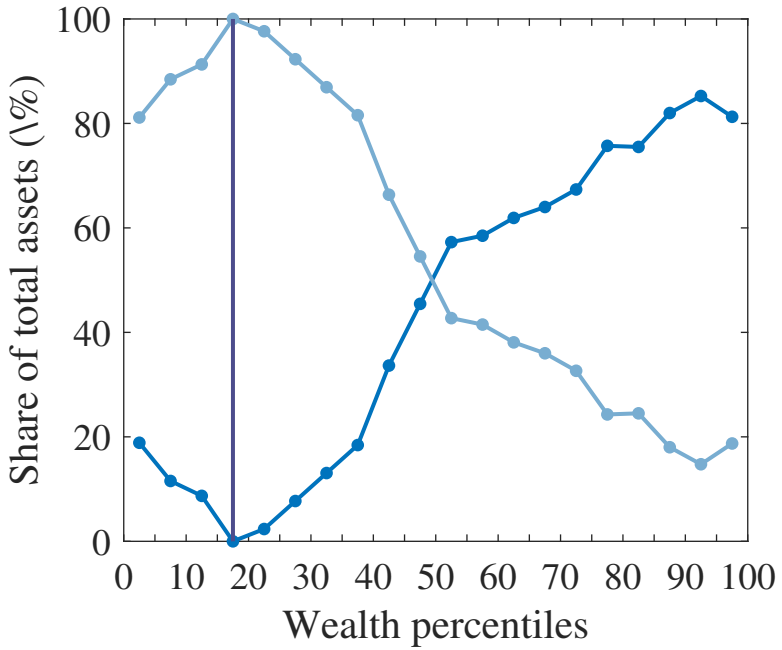
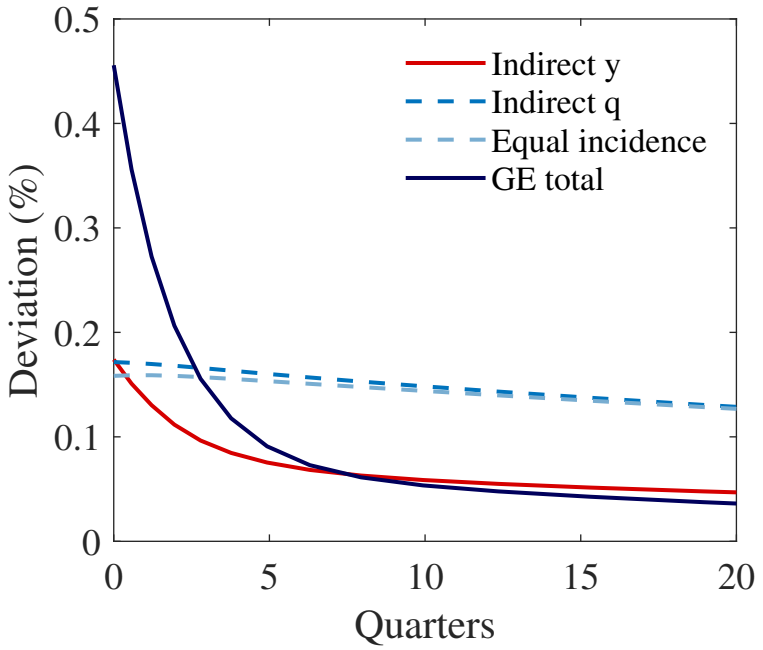
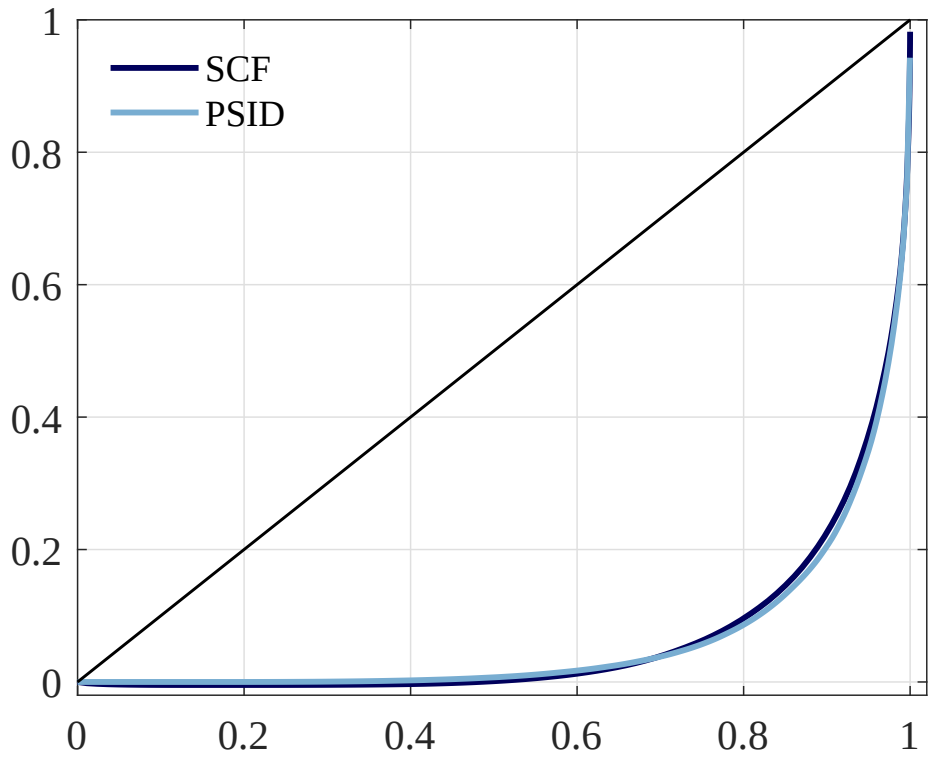
Wealth composition in the one-asset model





- Take portfolio shares from SCF microdata.
- Households at the top tilt their portfolios toward stocks.

Wealth in the SCF and PSID



Data

	Mean	Std. Deviation	10th P.	Median	90th P.
Age	44	11	29	44	59
Family size	2.8	1.5	1	2	5
Consumption	22,306	14,842	8,623	19,198	38,811
Cons. per person	9,501	6,984	3,374	7,864	17,152
Liquid assets	27,956	154,484	0	1,234	46,479
Earnings	51,755	48,021	1,478	41,600	105,748
Liquid assets (CE)	34,081	184,548	0	1,323	53,791
Liquid assets (SCF)	172,313	1,044,840	23	14,931	353,976

Note: Annual consumption shown. The last two rows report statistics for 2004 across surveys.

- SCF oversamples households at the top of the wealth distribution.
- CE covers most of SCF support and fits well the bottom and middle sections.

Data

Cross-sectional time series:

- Use information on wealth in the previous 12 months.
- Household i in quarter t is assigned to a group $g = 1, 2, ..., G$.
- Compute quarterly series of total consumption for each group.

Measurament errors, noise, and outliers:

- Winsorize consumption series at the top and bottom 1% in each quarter.
- Same for dependent variable used in the regressions.
- Smooth consumption with a moving average.

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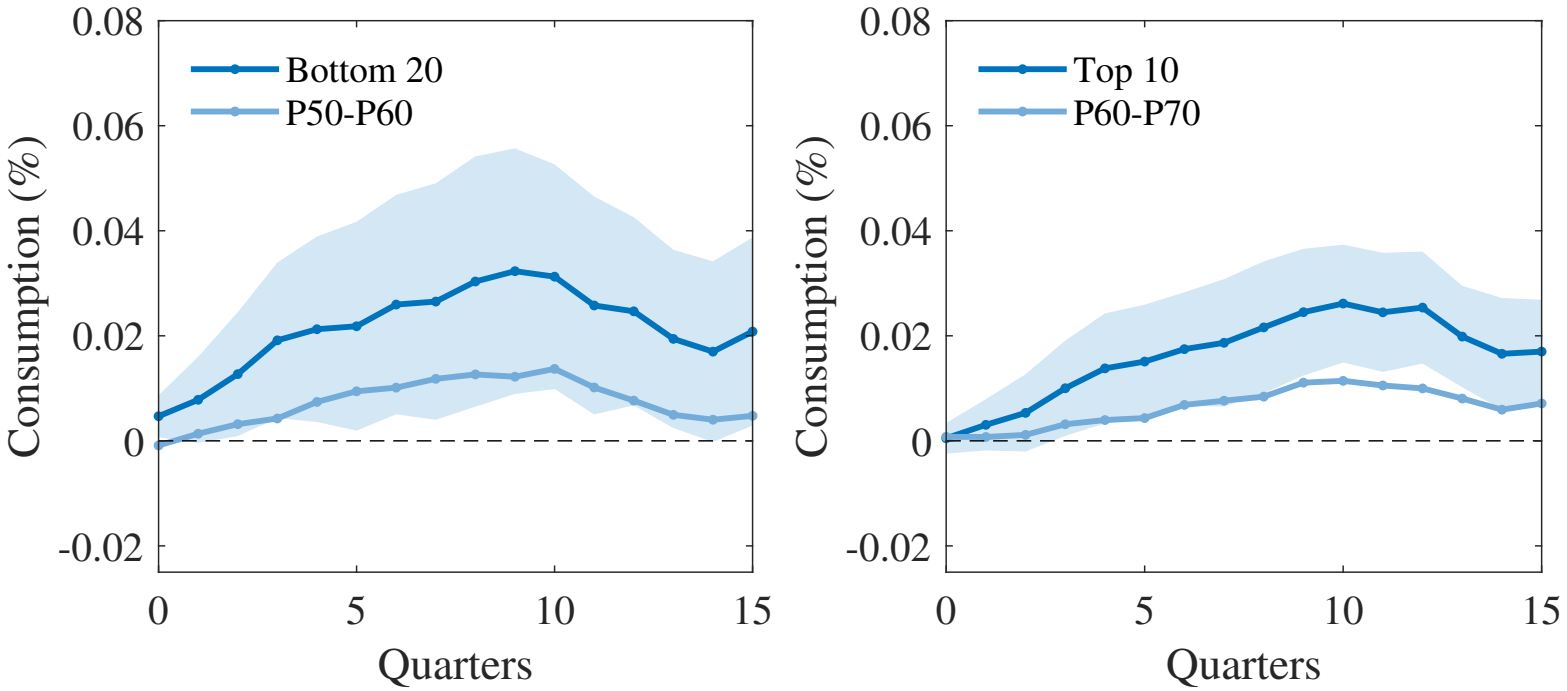
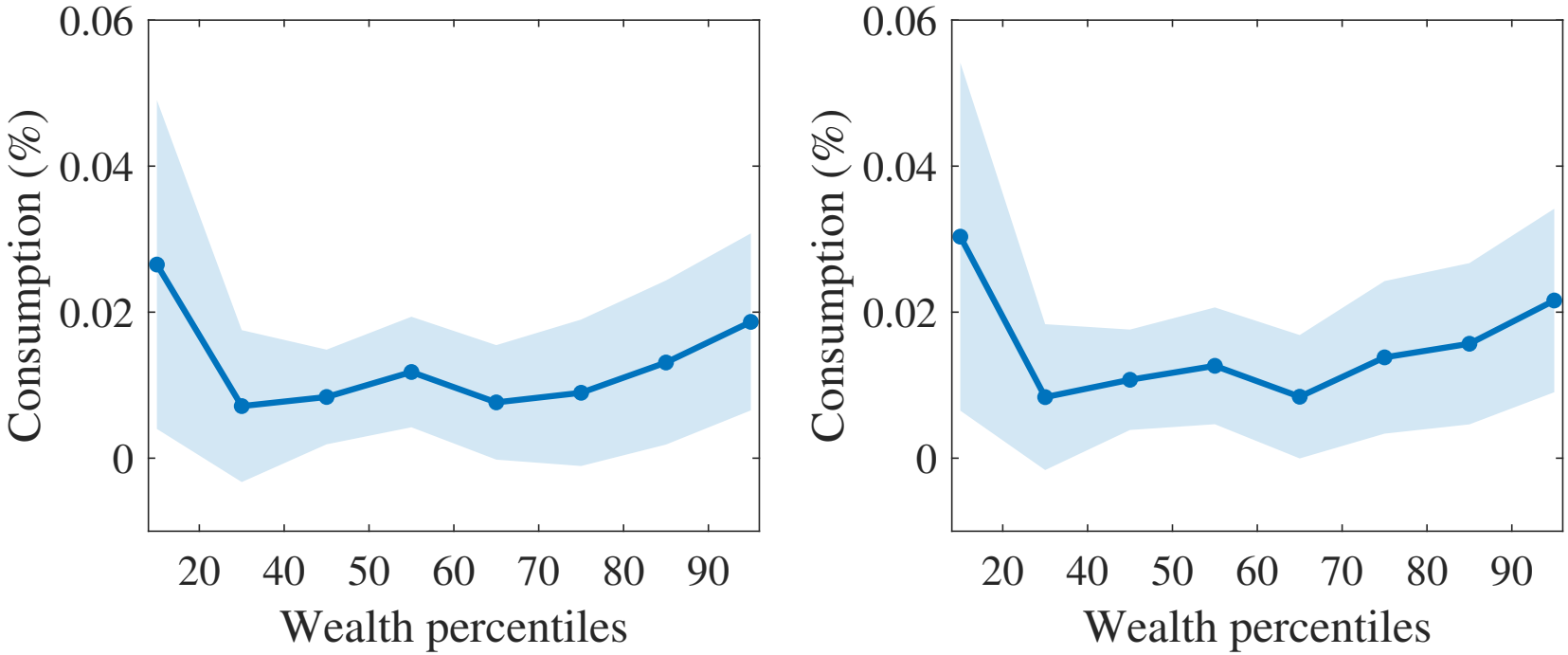
Robustness check - RR shocks



- 100 bp interest rate cut with RR series.
- The absolute size of the effects is lower (RR series has larger shocks).
- Same dynamics same cross-sectional pattern.

Robustness check - RR shocks



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Consumption shares