

# Stock price booms from technology news in a heterogeneous agent model with portfolio choice

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# Motivation: Stock price fluctuations

Stylized facts about the stock market:

- ▶ Stock prices co-move with the business cycle (especially investment)
- ▶ Stock-returns co-move with real return on liquid savings
- ▶ Ex-post rationalization: Time-varying discount rates, not dividends (Campbell and Shiller, 1988, Cochrane, 2011)

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- ▶ high parameter of relative risk aversion
- ▶ habit formation (Campbell and Cochrane, 1999)
- ▶ discount rate “shocks”

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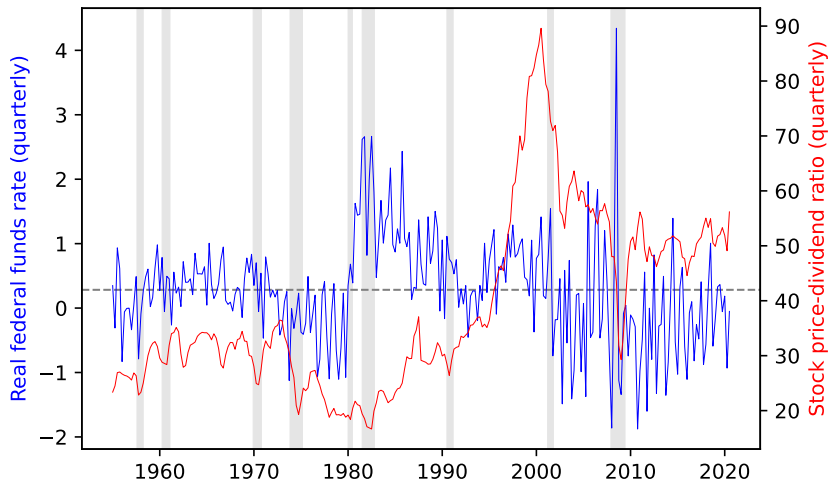
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# Motivation: real federal funds rate and stock market



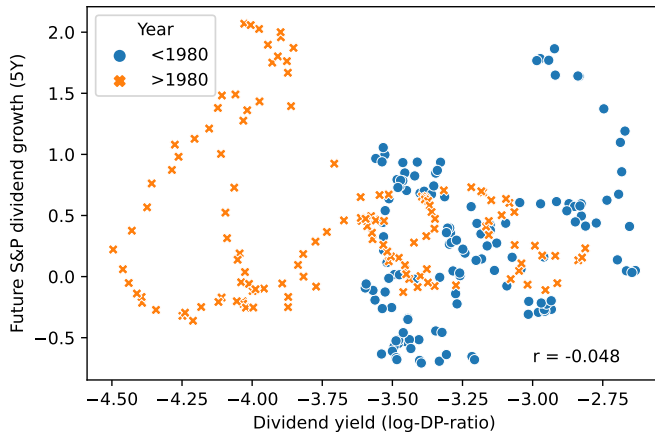
*Stock market: S&P 500 data by Robert Shiller. Shaded areas: NBER recession dates*

# Motivation: ex-post rationalization I

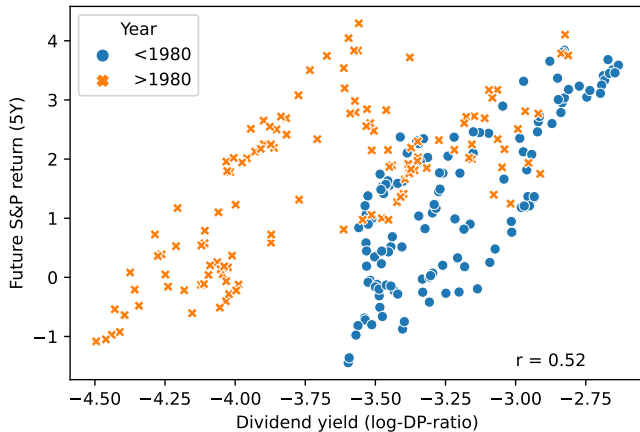
Campbell and Shiller (1988):

$$\log \left( \frac{\text{Dividend}}{\text{Stock price}_t} \right) = c + \mathbb{E}_t \sum_{j=0}^{\infty} \rho^j \left[ \underbrace{-\Delta \text{Dividend}_{t+1+j}}_{\text{dividend growth news}} \quad \underbrace{+r_{t+1+j}}_{\text{discount rate news}} \right], \quad (1)$$

# Motivation: ex-post rationalization II



# Motivation: ex-post rationalization III



*Stock market: S&P 500 data by Robert Shiller.*

# A novel, microfounded explanation

What do I do:

- ▶ Build a HANK model of the stock market, with portfolio choice (liquid and illiquid assets) and technology news

Preview of the results:

- ▶ News shocks generate a stock price boom-bust cycle via a time-varying discount rate
- ▶ Statistics in line with data:
  - ▶ comovement with investment, real return
  - ▶ realistic degree of fluctuations
- ▶ Micro-data in line with mechanism



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# Upshot of the mechanism

- ▶ good news generate high real returns
- ▶ investment boom as rich willing to hold more illiquid capital  $\rightarrow$  risk  $\uparrow$
- ▶ increases *liquidity value* of holding stocks
- ▶ anticipating *falling* capital rents induces rich to hold more liquid assets  $\rightarrow$  “bust” of the cycle, low real returns

## Key elements:

- ▶ *Illiquidity premium* of physical capital over publicly traded stocks
- ▶ Income effect of higher real returns for households with *high marginal propensity to invest* (MPI)
- ▶ Risk rises *endogenously* through portfolio choice: testable in survey data

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# Relations to literature

- ▶ **Macro-finance**

Time-varying risk-aversion (Campbell and Cochrane, 1999, Kekre and Lenel, 2021), long-run risk/uncertainty (Bansal and Yaron, 2004), trading frictions (Chien et al., 2012), learning/extrapolative expectations (Adam and Merkel, 2019)

- ▶ **Heterogeneous agents**

Time-varying idiosyncratic risk amplifies cycle, as in Ravn and Sterk (2017).  
“Rentiers” price liquid asset return, as in Bilbiie (2020).  
Importance of income-effects, wealthy-hand-to-mouth, illiquid investment: Kaplan et al. (2018), Auclert et al. (2020)

- ▶ **News literature**

News generate business cycle booms in New Keynesian model (Christiano et al., 2010), with financial frictions (Görtz et al., 2022)

## Model overview

# Household optimization

Household  $i$  solves

$$\max_{k_{it+1}, b_{it+1}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_{it}, n_{it}) \quad (2)$$

with period utility  $u$  including GHH-disutility in work  $n_i$ , CRRA  $\sigma$ , and

- ▶  $b_{it+1}$  liquid asset holding, ad hoc borrowing constraint  $\underline{b}$
- ▶  $k_{it+1}$  illiquid asset holding: adjustment-probability  $\lambda$  each period, non-negativity constraint
- ▶  $h_{it}$  idiosyncratic productivity

# Production sector

- ▶ Intermediate goods firms have technology

$$Y_t = A_t N_t^{1-\alpha_t} (u_t K_t)^{\alpha_t} \quad (3)$$

- ▶  $\alpha_t$  capital share of production, with

$$\alpha_t = (1 - \rho_\alpha) \bar{\alpha} + \rho_\alpha \alpha_{t-1} + \epsilon_{t-\ell}^{\alpha, \ell} + \epsilon_t^\alpha \quad (4)$$

- ▶  $\epsilon_{t-\ell}^{\alpha, \ell}$  news shock, known  $\ell$  periods in advance
- ▶ (results robust to TFP-news shock)
- ▶ Final goods firms: monopolistic competition, Calvo-price stickiness
- ▶ Smoothed profits  $\Pi_t^F = (\mu_t - 1) Y_t$  paid to entrepreneurs
- ▶ Distribute fraction  $\omega^\Pi$  as stock asset dividend  $div_t$

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# Factor and Profit incomes

|               | labor income | firm profits $\Pi^F$        | capital rents $r$ |
|---------------|--------------|-----------------------------|-------------------|
| workers       | with $h_i$   | via stocks, if $b_i \neq 0$ | if $k_i > 0$      |
| entrepreneurs | -            | lump-sum                    | if $k_i > 0$      |

- ▶ stochastic transition between workers and entrepreneurs
- ▶ additional:
  - ▶ labor union profits, lump-sum to workers
  - ▶ progressive tax-system (Heathcote et al., 2017)

## Asset returns

|                      | government bonds | profit shares = stocks                   | capital shares                 |
|----------------------|------------------|--|--------------------------------|
| liquid asset $b_i$   | $R_t^b / \pi_t$  | $(q_t^\Pi + \text{div}_t) / q_{t-1}^\Pi$ | -                              |
| illiquid asset $k_i$ | -                | -  | $R^k := (q_t + r_t) / q_{t-1}$ |

- ▶ under aggregate certainty, bond and stock returns equal ex-ante  
→ common stock-share  $s_t$  for all households
- ▶  $R^L :=$  ex-post return on  $b_i$

$$\begin{aligned}
 c_{it} + b_{it+1} + \mathbb{I}_{\{k' \neq k\}} q_t (k_{it+1} - k_{it}) \\
 \leq h_{it} N_t W_t + \mathbb{I}_{\{entr\}} \Pi_t^F + R_t^L b_{it} + r_t k_{it}
 \end{aligned} \tag{5}$$

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 \end{aligned} \tag{5}$$

# Government sector

- ▶ Taylor rule

$$\frac{R_{t+1}^b}{\bar{R}^b} = \left( \frac{R_t^b}{\bar{R}^b} \right)^{\rho_R} \left( \frac{\pi_t}{\bar{\pi}} \right)^{(1-\rho_R)\theta_\pi} \left( \frac{Y_t}{Y_t^*} \right)^{(1-\rho_R)\theta_Y} \quad (6)$$

- ▶ Fiscal rule

$$\frac{B_{t+1}}{B_t} = \left( \frac{B_t}{\bar{B}} \right)^{-\gamma_B} \left( \frac{\pi_t}{\bar{\pi}} \right)^{-\gamma_\pi} \left( \frac{Y_t}{Y_t^*} \right)^{-\gamma_Y} \quad (7)$$

→ determine net bond supply  $B_{t+1}$ , real rate  $R_t^b/\pi_t$

- ▶ Government adjusts expenditure to fulfill budget:

$$G_t = B_{t+1} + T_t - R_t^b/\pi_t B_t$$

# Calibration

## Mapping: Household portfolio $\rightleftharpoons$ Production sector

$$\text{Liquid asset: } \left\{ \begin{array}{c} \text{Cash, Deposits} \\ \text{Bonds} \\ \text{Mutual funds, public equity} \\ \text{Credit card debt} \end{array} \right\} \rightarrow \left\{ \begin{array}{c} \text{Government bonds} \\ \text{public stock} \end{array} \right.$$

$$\text{Illiquid asset: } \left\{ \begin{array}{c} \text{Housing} \\ \text{Pensions, life insurance} \\ \text{Other real estate, private equity} \\ \text{Real estate debt} \end{array} \right\} \rightarrow \text{Fixed assets (BEA)}$$

Stockshare within liquid asset category calibrated to  $s = 0.39$  (mid-1990s)

# Parameter choice

- ▶ Model also has capital production sector with adjustment costs, wage stickiness, endogenous idiosyncratic risk
- ▶ Micro-parameters calibrated to micro evidence in the SCF:  $\sigma = 4$ ,  $\lambda = 6.5\%$
- ▶ Calibrate  $R^K = 3.7\%$ ,  $R^L = 2.5\%$
- ▶ Macro-parameters taken as estimated in Bayer et al. (2020)

## Additional calibrations:

- ▶ Stock depreciation, dividend smoothing: calibrated to match moments of S&P 500
- ▶ News shock, government bond supply elasticity calibrated to match evidence from 1990s stock-price boom
  - ▶ anticipation horizon: 5 years

# Experiment

- ▶ 3 exogenous shocks: surprise TFP-shocks, surprise price markup-shocks, News about capital share in production
    - ▶ Stochastic processes estimated in Bayer et al. (2020) (surprise shocks) / calibrated from 1990s (news shock)
  - ▶ 3 model varieties:
    - ▶ HANK with Two Assets (baseline)
    - ▶ HANK with One Asset
    - ▶ RANK
- where time-discount factors  $\beta$  calibrated such that  $R^L = 2.5\%$  in all models
- ▶ 2 types of results: Moments from simulation and analysis of news-induced boom-bust-episode



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## Results

# Simulation: stock returns and the business cycle

| Variables                            | Data      | (I)   | (II)  | (III) | (IV)  |
|--------------------------------------|-----------|-------|-------|-------|-------|
| $mean(P/D)$                          | 152*      | 151   | 148   | 147   | 146   |
| $\sigma(P/D)$                        | 63        | 48    | 35    | 28    | 28    |
| $\rho(P/D)$                          | 0.98      | 0.986 | 0.985 | 0.99  | 0.996 |
| $\rho(\Delta P/D)$                   | 0.99      | 0.11  | 0.01  | 0.41  | 0.41  |
| $\sigma(\Delta D)$                   | 1.75%*    | 1.74% | 1.27% | 1.81% | 1.49% |
| $\rho(I/Y, P/D)$                     | 0.58      | 0.62  | 0.32  | -0.05 | -0.24 |
| $\rho(\Delta I/Y, \Delta P/D)$       | 15%       | 34%   | 29%   | 4.8%  | -22%  |
| $\rho(\Delta C/Y, \Delta P/D)$       | 10%       | 2.1%  | -58%  | 7.9%  | -72%  |
| $\rho(R^b/\pi, R^{stocks})$          | 0.13-0.19 | 0.24  | 0.24  | 0.05  | -0.11 |
| $\sigma(R^{stocks})$                 | 7.28%     | 5.07% | 4.27% | 1.63% | 1.45% |
| $\sigma(R^{stocks})/\sigma(R^b/\pi)$ | 1.7-8.9   | 2.9   | 5.3   | 3.7   | 4.26  |

(I): Two-Asset HANK with News

(II): Two-Asset HANK without News

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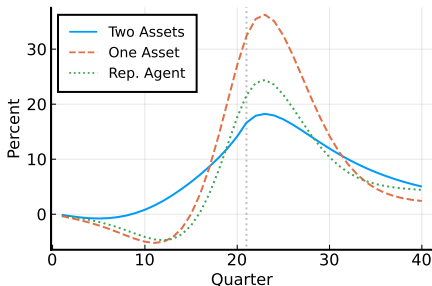
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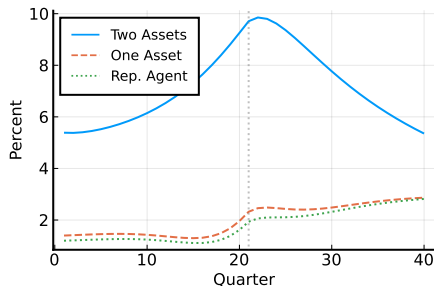
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# Stock price cycle from technology news

- ▶ Shock: news about transitory higher future capital share in production (alternatively: TFP), 5-year horizon
- ▶ Compare across model varieties: with liquid capital (*One Asset*), complete markets (*Rep. Agent*)



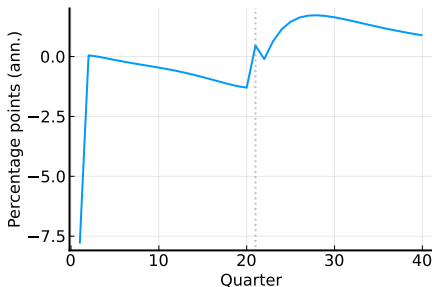
(a) Investment



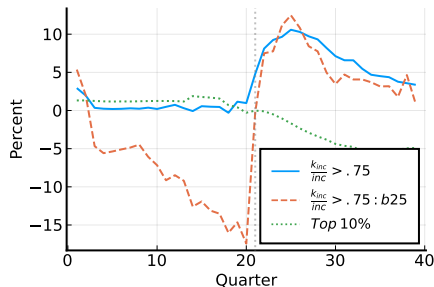
(b) Stock price



# Illiquidity premium and marginal saver



(a) Illiquidity premium  $R^K - R^L$



(b) Portfolio liquidity of top 10%  
(b25: lowest quartile of portf.-liqu. distr.)

*Portfolio liquidity*: share of liquid wealth over total wealth

- ▶ Heterogeneity allows identification of marginal saver: households with income dominated by capital rents
- ▶ increase consumption risk in anticipation phase Theory

## Evidence for Microfoundation

# Data: Asset returns I

Theory implies that

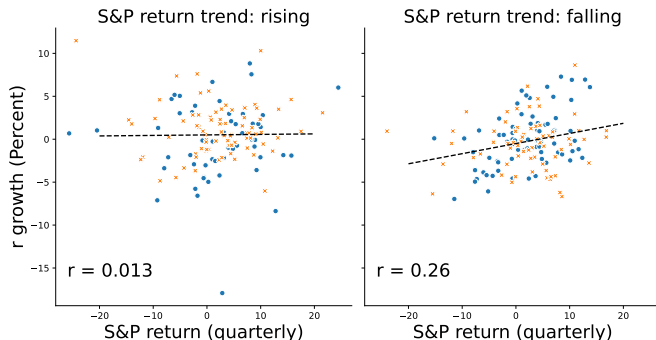
- ▶ expected returns on stock market covary with expected bond returns (see above)
- ▶ capital rents decline in stock price-busts

To check with the data, I use

- ▶ S&P 500 returns
- ▶ Gomme et al. (2011) capital return series

# Data: Asset returns II

## (a) Capital rents



Notes: S&P return trend computed using HP-filter ( $\lambda = 1600$ ). Blue dots: before 1980. Orange crosses: after 1979. No capital gains, after-tax.

# Survey evidence for marginal saver (“Rentiers”)

- ▶ Definition: hhs with capital income  $> 75\%$  of total income
- ▶  $\sim 1.5\%$  of households in the data
- ▶ Compute portfolio liquidity  $:= \frac{\text{liquid wealth}}{\text{total wealth}}$
- ▶ Use *relative* portfolio liquidity within top 10%

## Capital income:

- ▶ In SCF+, sums up to
  - (1) non-taxable investments (e.g. municipal bonds) +
  - (2) other interest + (3) dividends +
  - (4) other businesses or investments, net rent, trusts, or royalties
- ▶ Robustness: use only (4) as capital income  
Problem: separately only available since 1983

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## Regression: price-dividend ratio on portfolio liquidity

$$\Delta_i \frac{q^p}{d} = \sum_g \beta_g \Delta_i \text{pflq}^g + \epsilon_i, \quad i = 1, \dots, 19$$

| Variables        | (I)      | (II)   | (III)   | (IV)     | (V)     |
|------------------|----------|--------|---------|----------|---------|
| high cap. inc.   | -0.290   | -0.361 | -0.477* | -0.381** | -0.876* |
| middle 40%       | 0.113    | -0.089 | 0.824*  | 0.086    | 0.482   |
| bottom 50%       | -0.442** | -      | -0.27   | -0.481** | -0.237  |
| rel. stock share | -        | -      | -       | 0.420*   | 0.679   |

Notes: All variables are standardized.

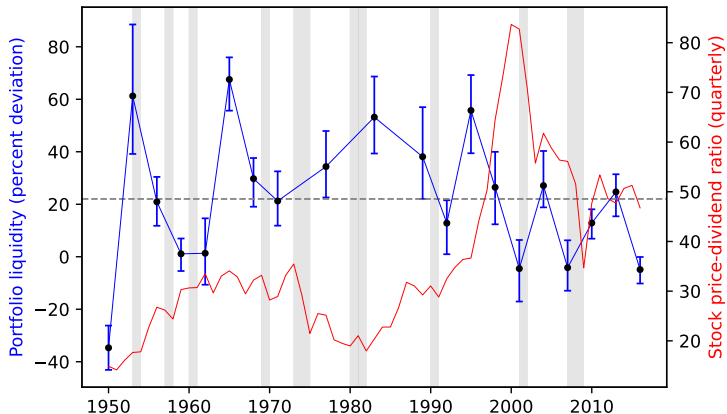
(III) & (V): all regressors are indicator variables  $\mathbb{I}_{\{\Delta_i \text{pflq}^g > 0\}}$  (not standardized).

(IV) & (V): include growth of ratio of the stock share of high capital-households by the stock share of households in the top 10% as a regressor.

Newey-West (one lag) standard errors. Asterisks indicate t-statistic of coefficient above the 5% (\*\*) or 10% (\*) level.

For narrower capital income definition, results are robust

# Relative portfolio liquidity and S&P 500



*Portfolio liquidity:* ratio of portfolio liquidity of households with high capital income share ( $> 75\%$ ) by portfolio liquidity of top 10%. Data: SCF+ (Kuhn et al., 2020)

*Stock market:* S&P 500 data by Robert Shiller. *Whiskers:* 68% CIs



General equilibrium channels

# General equilibrium channels I

## Elasticity of liquid asset supply

- ▶ lower demand for liquid assets in the anticipation phase (expected higher income)
- ▶ no bond supply reduction → inflation
- ▶ → investment boom *inhibited*: rich households with high marginal propensities to invest lose

To *harness* the positive news to have more productive (i.e. illiquid) portfolios, government needs to stabilize inflation by lowering bond supply

plots

# General equilibrium channels II

## Extensive margin of capital holding

- ▶ the investment-boom is driven by *intensive* margin of wealthy households
- ▶ in bottom 50%, more households abstain from holding capital in anticipation phase, when illiquidity premium low (can profit from stock price boom)
- ▶ they buy capital *after* the boom, when illiquidity premium high

High capital price from extensive margin-demand incentivizes investment-boom

## Conclusion

# Conclusion & Outlook

- ▶ Incomplete markets generate stock price fluctuations via time-varying illiquidity premium
- ▶ Portfolio choice and anticipation together produce investment-driven stock-price booms
- ▶ Microfoundation testable with survey data

Outlook: modelling aggregate risk

- ▶ Conjecture: LP-channel becomes *more* important in boom: higher stock-shares in boom implies higher risk premia, lowering stock prices
- ▶ Analyze heterogeneous stock shares: aggregate and welfare implications

# Conclusion & Outlook

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## Appendix

# Theory: Consumption-based asset pricing with het. agents

I show that (without aggregate risk)

$$LP_t := R_t^K - R_t^L \geq \beta(1 - \lambda) \frac{\mathbb{E}[\gamma_{t+1,i}]}{u'(c_{t,i})q_t} \quad (8)$$

for all households  $i$

$\gamma_i$  := shadow price of selling capital

Implications:

- ▶  $LP$  low in anticipation phase  $\rightarrow$  implies business cycle boom: *all* households expect rising income
- ▶  $LP$  high after realized capital returns  $\rightarrow$  *some* households have high  $\gamma_i$ : “Rentiers” with largest expected (capital) income decline

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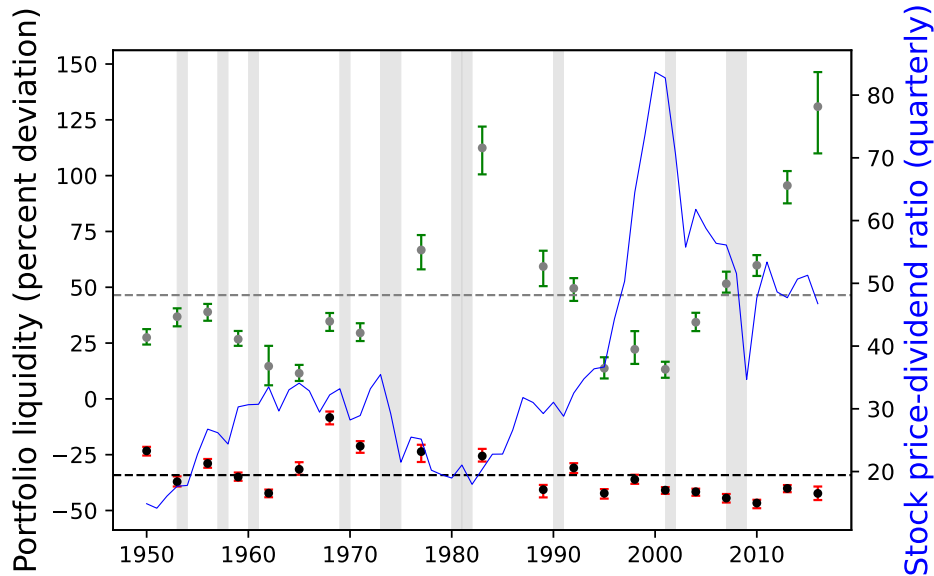
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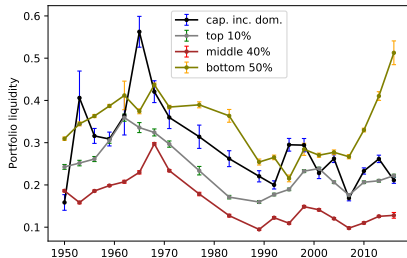
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## Relative portfolio liquidity of bottom 90%

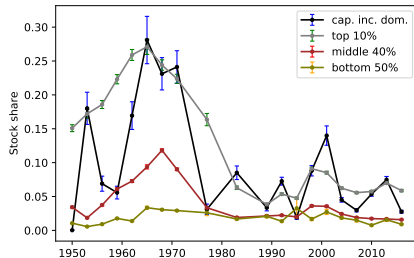


# Survey of Consumer Finances: Heterogeneous Portfolios I

(a) Portfolio liquidity



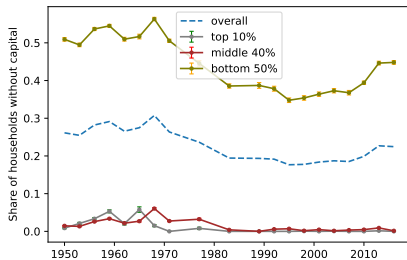
(b) Stock shares



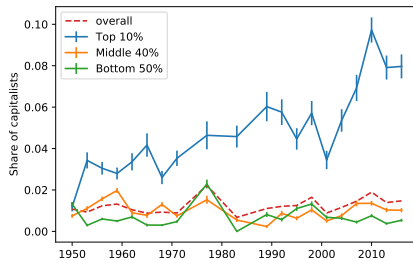
Source: SCF+ (Kuhn et al., 2020)

# Survey of Consumer Finances: Heterogeneous Portfolios II

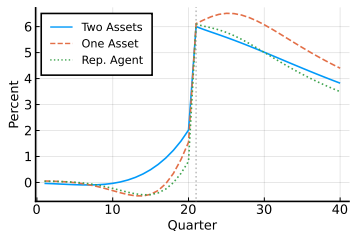
(a) Households without capital



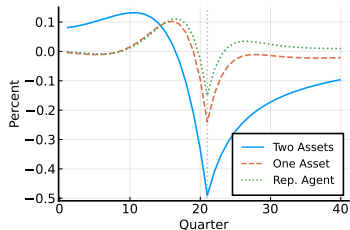
(b) Households with high capital income



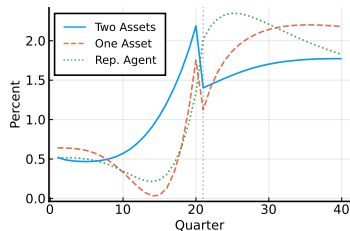
# Impulse responses to news shock [back](#)



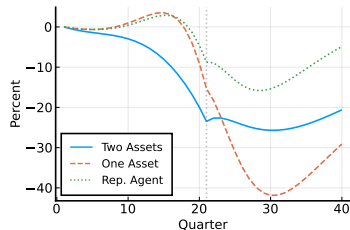
(a) Output



(c) Inflation



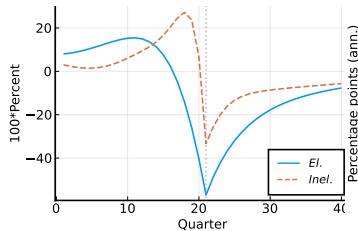
(b) Consumption



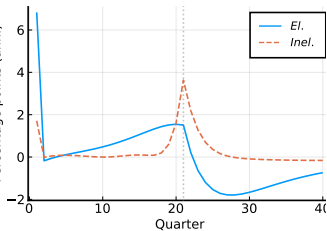
(d) Government bonds



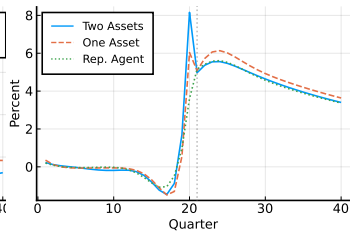
# Importance of liquid asset supply elasticity [back](#)



(a) Inflation



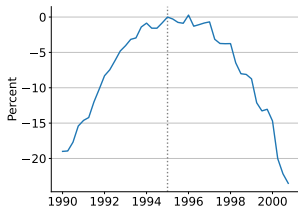
(b) Real liquid return



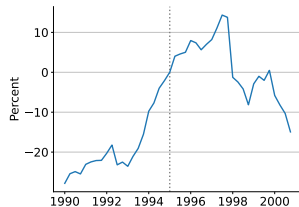
(c) Output (Inel.)

# Empirical data series

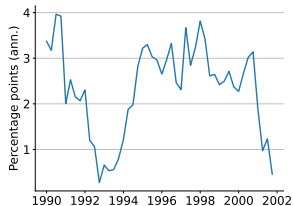
(a) Federal debt (real, growth-adj.)



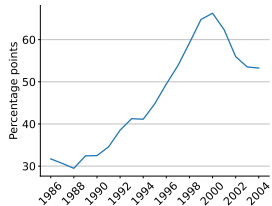
(b) Corporate profits (real, growth-adj.)



(c) 3-M T-Bill (real)

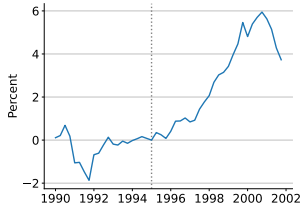


(d) Share of Stocks in liquid assets

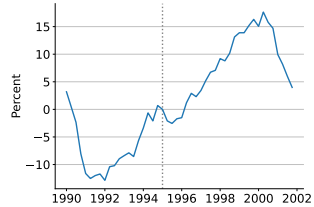


# Empirical data series (business cycle)

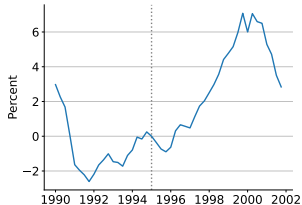
(a) Consumption (real, growth-adj.)



(b) Investment (real, growth-adj.)



(c) Output (real, growth-adj.)



(d) Governm. expend. (real, growth-adj.)

