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

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"But in what sense is it a good general equilibrium fit if the quantities are right but not the prices?" - Ricardo Caballero, 2010

Motivation: Stock price fluctuations

Stylized facts about the stock market:

- Stock prices co-move with the business cycle (especially investment)
- High degree of momentum ("boom-bust cycle")
- Time-varying discount rates, but not dividends, can ex-post rationalize stock price fluctuations (Campbell and Shiller, 1988, Cochrane, 2011)

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- high parameter of relative risk aversion
- habit formation (Campbell and Cochrane, 1999)
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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:

- Technology news generate a stock price boom-bust cycle via a time-varying discount rate
- Statistics in line with data:
  - comovement with investment
  - realistic degree of fluctuations

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Upshot of the mechanism

- Publicly traded stocks carry *liquidity premium*, compared to illiquid capital
- Time-varying *idiosyncratic* risk of households moves the stock price
- Risk arises *endogenously* through portfolio choice, which can be *tested in survey data*

Novel perspective on stock market booms:

- elasticity of aggregate liquidity supply (e.g. via government debt) crucial
- identify *marginal saver*, in both model and data, that drives stock price boom-bust cycles

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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). "Capitalists" price liquid asset return, as in Bilbiie (2020). Importance of illiquid investment in HANK as in 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

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

with period utility u including GHH-disutility in work n_i, CRRA σ, and

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

Households subject to idiosyncratic income risk:

- labor income y_{it} follows Markov chain
- With small probability, households gain or lose status of entrepreneurs: receive profits from monopolistically competitive firms

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Asset structure

Liquid assets include government bonds and tradable profit-shares (stocks):

- bond return R_t^b/π_t
- stock return $\frac{(1-\iota^{\Pi})q_t^{\Pi}+div_t}{q_{t-1}^{\Pi}}$

Households neglect aggregate risk $\rightarrow$ identical ex-ante liquid asset returns

$R_t^L :=$ ex-post return on liquid asset holdings

Illiquid asset is capital that households rent out to firms for production. Trades at price q.

Household budget:

$$c_{it} + b_{it+1} + \mathbb{I}_{\{k' \neq k\}} q_t (k_{it+1} - k_{it}) \leq y_{it} + \mathbb{I}_{\{entr\}} \text{profits}_t + R_t^L b_{it} + r_t k_{it} \quad (2)$$

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Production sector

- Intermediate goods firms have technology

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

- α_t capital share of production, with

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

- $\epsilon_{t-\ell}^{\alpha,\ell}$ news shock, known ℓ periods in advance

- monopolistically competitive final goods firms, Calvo-price stickiness: profits $\Pi_t^F = (1 - mc_t) Y_t$
- Excess firm profits $\Pi_t^F - \overline{\Pi^F}$ saved via investment rule in bonds, smoothed profits payed to entrepreneurs, who distribute fraction ω^{Π} as stock asset dividend div_t

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Government sector

- Taylor rule

$$\frac{R^b_{t+1}}{\bar{R}^b} = \left(\frac{R^b_t}{\bar{R}^b}\right)^{\rho_R} \left(\frac{\pi_t}{\bar{\pi}}\right)^{(1-\rho_R)\theta_\pi} \left(\frac{Y_t}{Y^*_t}\right)^{(1-\rho_R)\theta_Y} \tag{5}$$

- Fiscal rule

$$\frac{B_{t+1}}{B_t} = \left(\frac{B_t}{\bar{B}}\right)^{-\gamma_B} \left(\frac{\pi_t}{\bar{\pi}}\right)^{-\gamma_\pi} \left(\frac{Y_t}{Y^*_t}\right)^{-\gamma_Y} \tag{6}$$

  $\rightarrow$ determine net bond supply B_{t+1}, real rate R^b_t/π_t

- Government adjusts expenditure to fulfill budget:
  $G_t = B_{t+1} + T_t - R^b_t/\pi_t B_t$

Parameter choice

- Model also features capital adjustment costs, wage stickiness, endogenous idiosyncratic risk
- Micro-parameters calibrated to micro evidence in the SCF: $\sigma = 4$, $\lambda = 6.5\%$
- Calibrate $R^L = 2.5\%$, $R^K = 3.7\%$
- 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 β 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

stats	Data	(I)	(II)	(III)	(IV)
$mean(P/D)$	152*	151	148	145	148
$\sigma(P/D)$	63	48	36	28	26
$\rho(P/D)$	0.98	0.985	0.985	0.99	0.995
$\rho(\Delta P/D)$	0.99	0.1	0.0	0.38	0.38
$\sigma(\Delta D)$	1.75%*	1.66%	1.21%	1.73%	1.43%
$\rho(Y, C)$	0.88	0.9	0.98	0.9	0.98
$\rho(Y, I)$	0.86	0.81	0.8	0.59	0.56
$\rho(I/Y, P/D)$	0.58	0.62	0.33	-0.03	-0.25
$\rho(\Delta I/Y, \Delta P/D)$	15%	33%	29%	-2.7%	-11%
$\rho(\Delta C/Y, \Delta P/D)$	10%	1.6%	-58%	6.3%	-72%
$\rho(\Delta B^{gov}/Y, \Delta P/D)$	-5%	-24%	-30%	-20%	-47%
$\rho(R^b/\pi, R^{stocks})$	0.13-0.19	0.23	0.24	0.03	-0.1
$\sigma(R^{stocks})$	7.28%	5.12%	4.32%	1.64%	1.45%
$\sigma(R^{stocks})/\sigma(R^b/\pi)$	1.7-8.9	3.1	5.4	4	4.7

(I): Two-Asset HANK with News
(II): Two-Asset HANK without News
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(*): targeted moments

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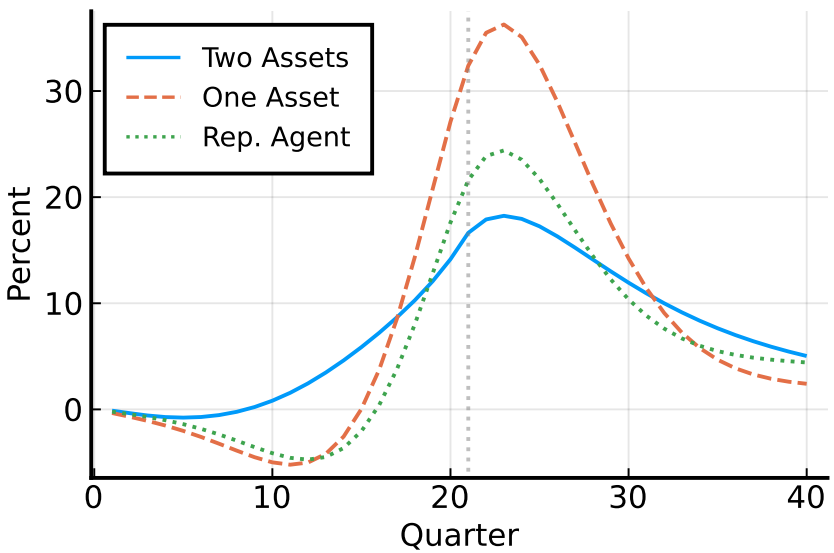
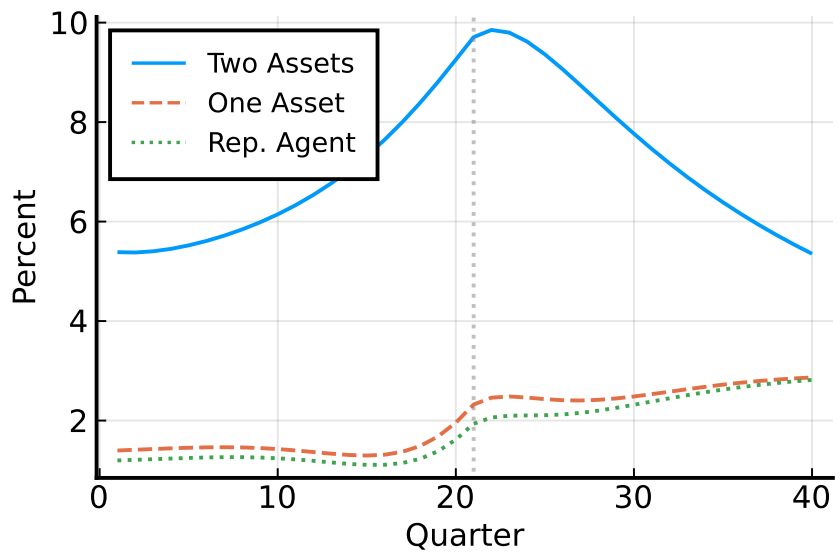
Stock price cycle from technology news

- 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

Theory: Consumption-based asset pricing with het. agents

I show that (without aggregate risk)

$$LP_t := R_t^K - R_t^L \geq \beta(1-\lambda)\frac{\mathbb{E}\left[\gamma_{t+1,i}\right]}{u'(c_{t,i})q_t} \tag{7}$$

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 γ_i: "capitalists" with largest expected (capital) income decline

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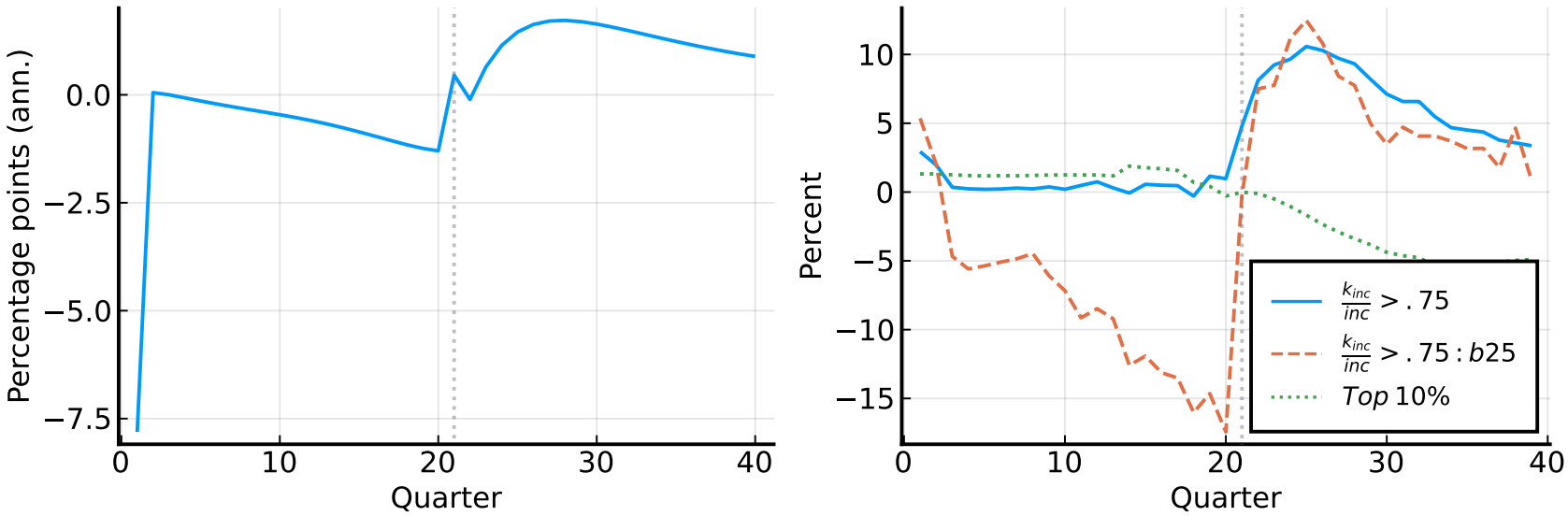
Liquidity premium and marginal saver



(a) Liquidity 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

Evidence for Microfoundation

Asset returns I

Theory implies that

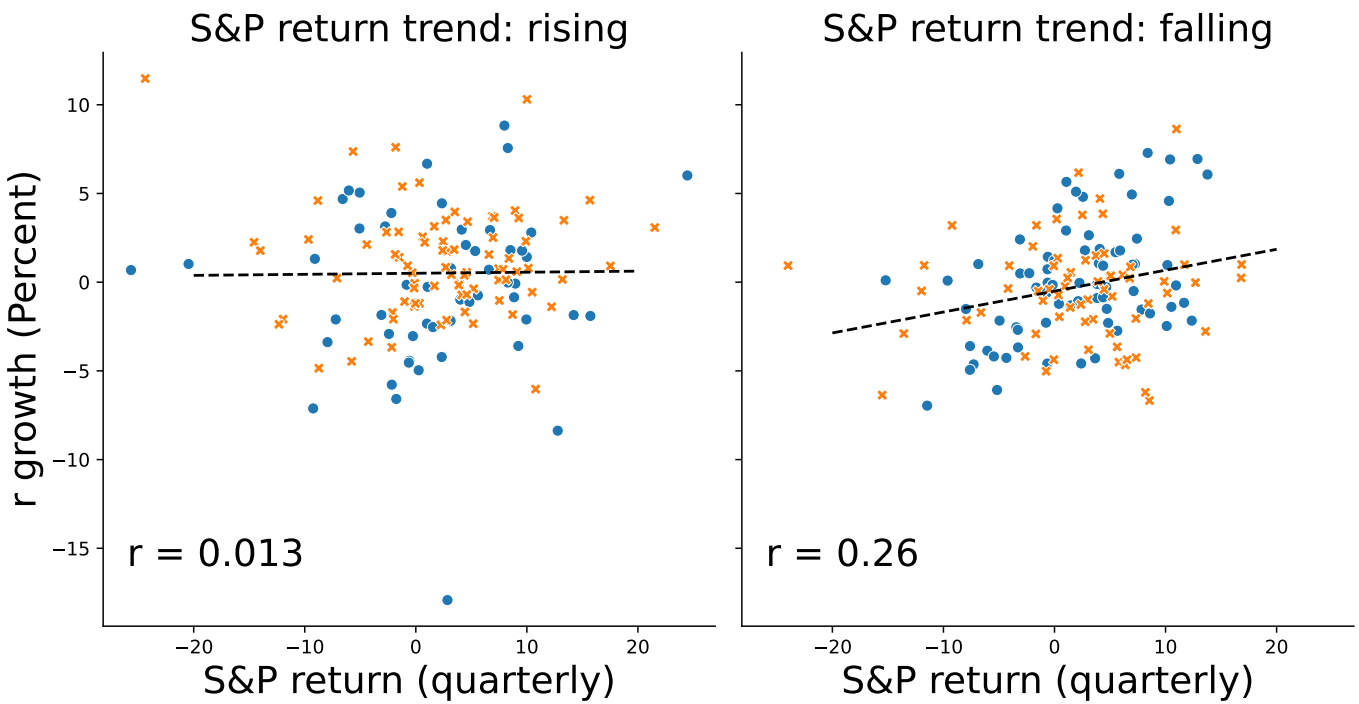
- expected returns on stock market covary with expected bond returns (see above)
- capital rents decline in stock price-busts

To check with the data, I use

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

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 ("capitalists")

- Identify as households where capital income is larger than 75% of total income
- In SCF+, capital income 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
- Amounts to $\sim 1.5\%$ of households in the data
- Then, compute portfolio liquidity as $\frac{\text{liquid wealth}}{\text{total wealth}}$

Regression

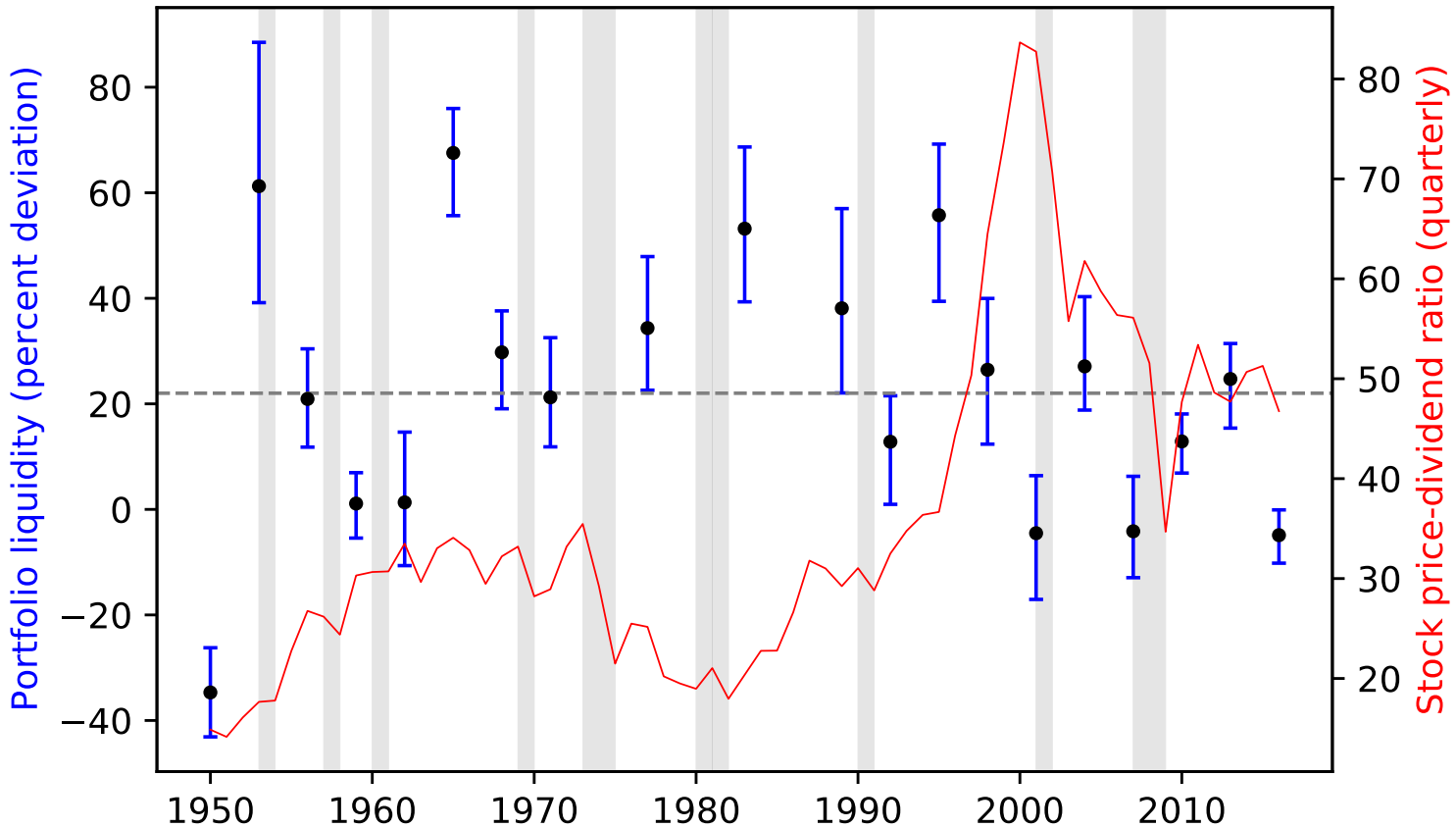
$$\Delta_i \frac{q^{\Pi}}{d} = \sum_g \beta_g \Delta_i \text{pflq}^g + \epsilon_i,\ i = 1, .., 19$$

$\Delta(Price/Div.)$	(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

patterns

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 $\rightarrow$ inflation
- $\rightarrow$ 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, goverment needs to stabilize inflation by lowering bond supply

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 liquidity premium low (can profit from stock price boom)
- they buy capital *after* the boom, when liquidity premium high

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

Conclusion

Conclusion & Outlook

- Incomplete markets generate stock price fluctuations via time-varying liquidity 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

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Appendix

Portfolio liquidity and the stock market

Regression of price-dividend growth on relative portfolio liquidities

Specs	high cap. inc.	middle 40%	bottom 50%	rel. stock share
baseline	-0.290 (0.213)	0.113 (0.117)	-0.442** (0.118)	-
w/o b50%	-0.361 (0.235)	-0.089 (0.109)	-	-
bin. regr.	-0.477* (0.228)	0.824* (0.409)	-0.27 (0.266)	-
stock share	-0.381** (0.168)	0.086 (0.116)	-0.481** (0.133)	0.420* (0.228)
st.sh. & bin.	-0.876* (0.483)	0.482 (0.310)	-0.237 (0.242)	0.679 (0.520)

Notes: The baseline regression equation is $\Delta_i \frac{q^\Pi}{d} = \sum_g \beta_g \Delta_i \text{pflq}^g + \epsilon_i$, $i = 1, .., 19$. All variables are standardized. In *binary* specifications, all regressors are instead indicator variables $\mathbb{I}_{\{\Delta_i \text{pflq}^g > 0\}}$ (not standardized). Specifications with the *relative stock share* include the growth of the 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 in parentheses. Asterisks indicate that the t-statistic of the coefficient is above the 5% (**) or 10% (*) level.

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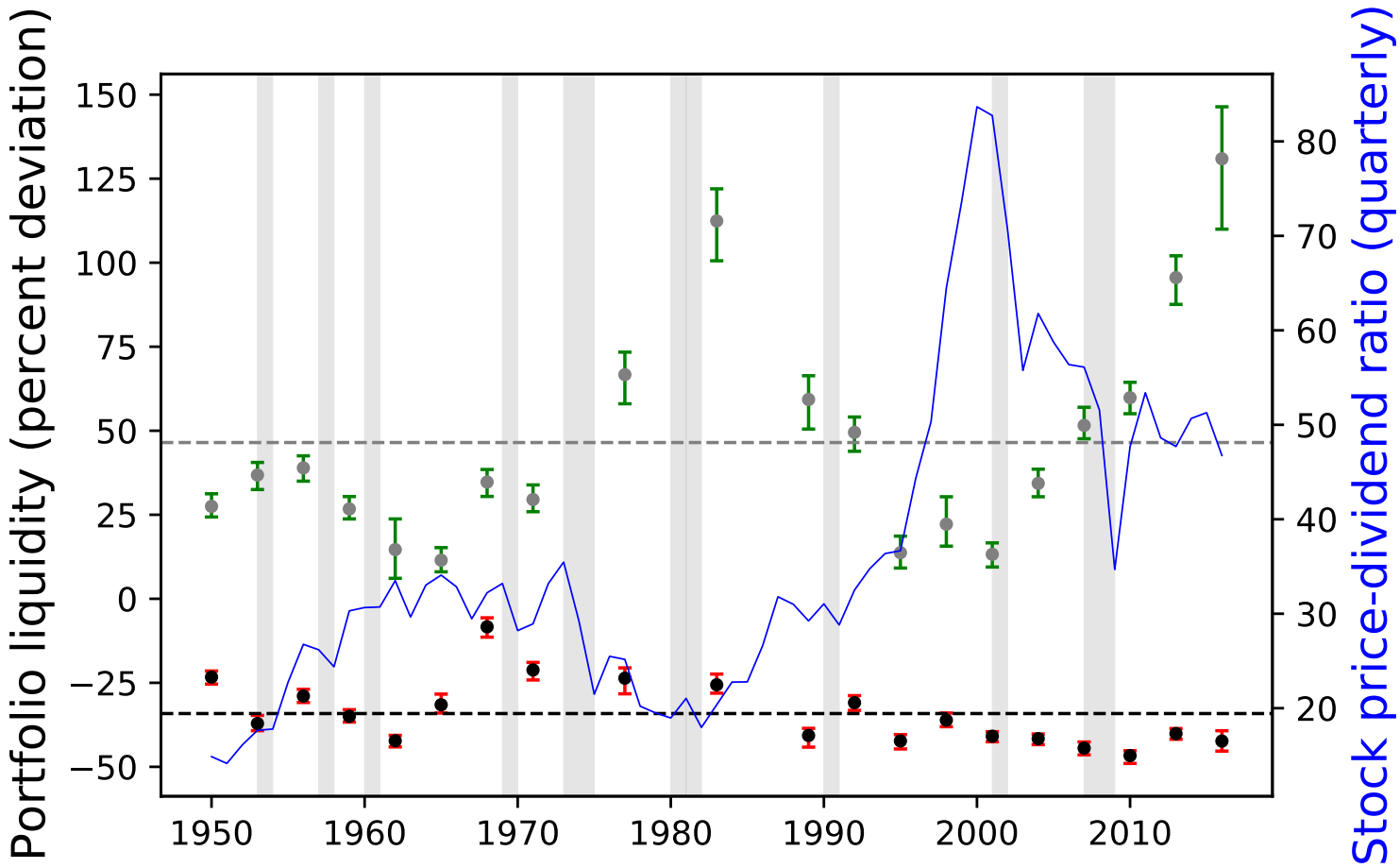
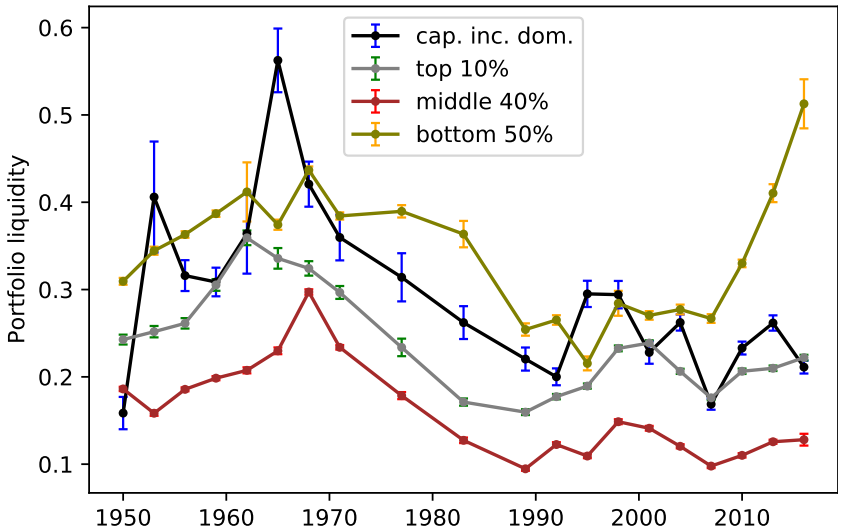
Relative portfolio liquidity of bottom 90%



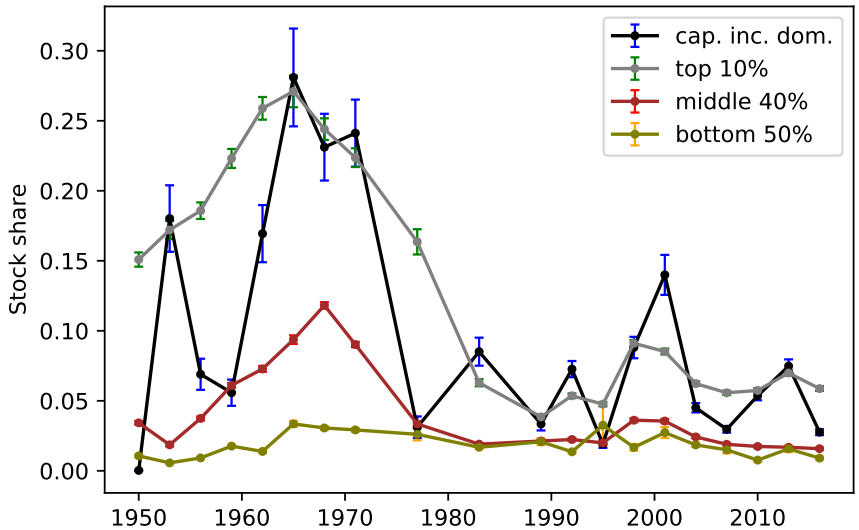
Portfolio liquidity: relative deviation of portfolio liquidity of households in the bottom 50% (grey dots, green CIs) / middle 40% (black dots, red CIs) from portfolio liquidity of the top 10% of wealth distribution. Data: SCF+ (Kuhn et al., 2020)
Stock market: S&P 500 data by Robert Shiller. *Whiskers*: 68% CIs

Survey of Consumer Finances: Heterogeneous Portfolios I

(a) Portfolio liquidity



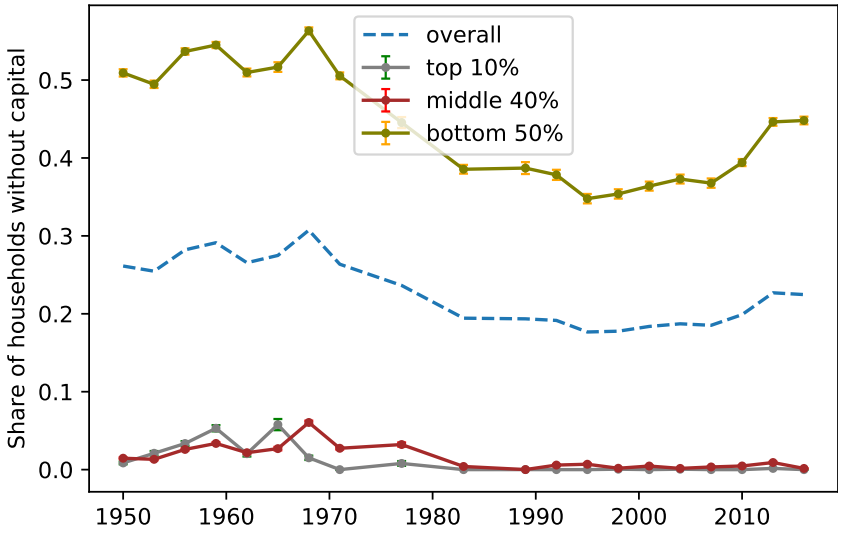
(b) Stock shares



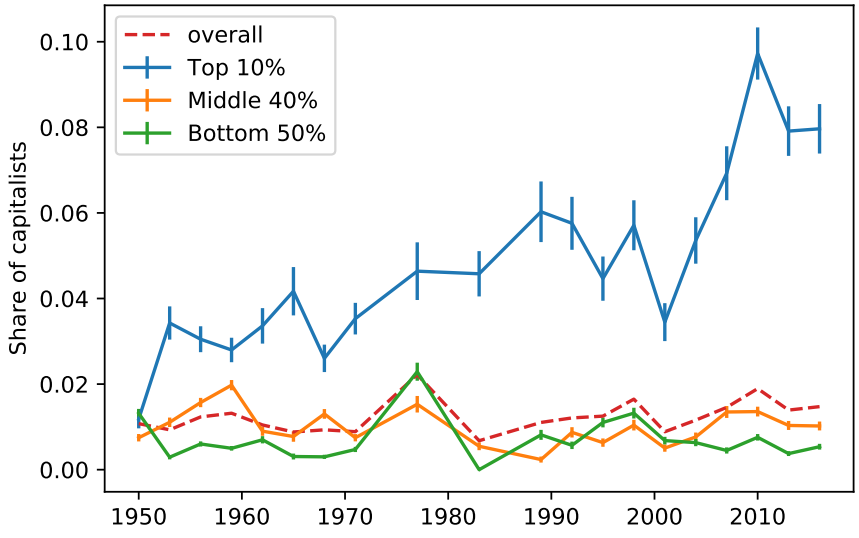
Source: SCF+ (Kuhn et al., 2020)

Survey of Consumer Finances: Heterogeneous Portfolios II

(a) Households without capital



(b) Households with high capital income



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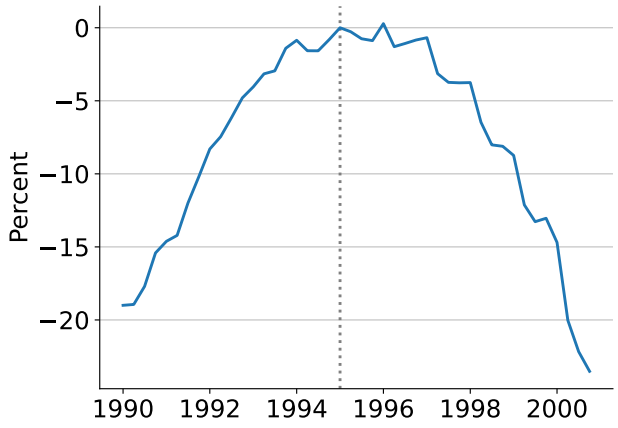
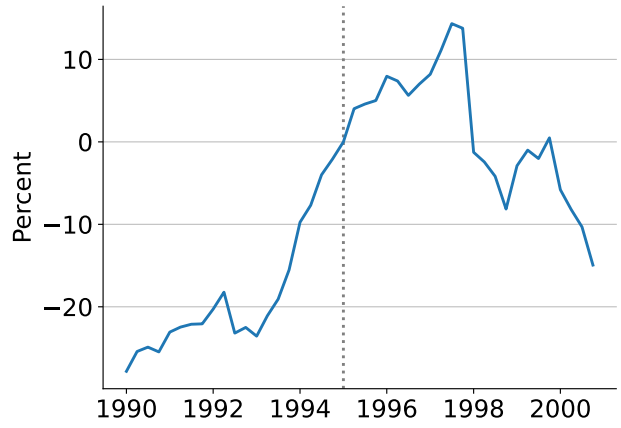
Empirical data series

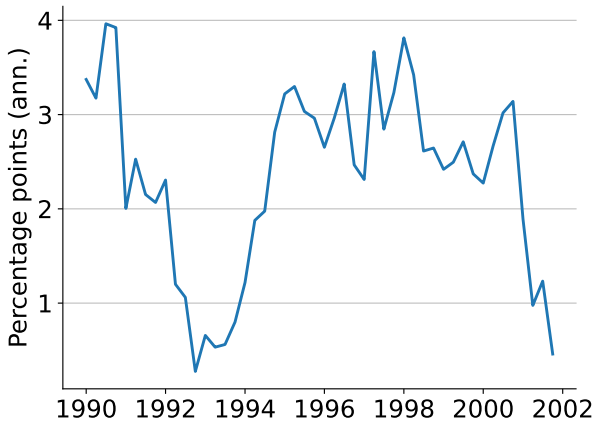
(a) Federal debt (real, growth-adj.)



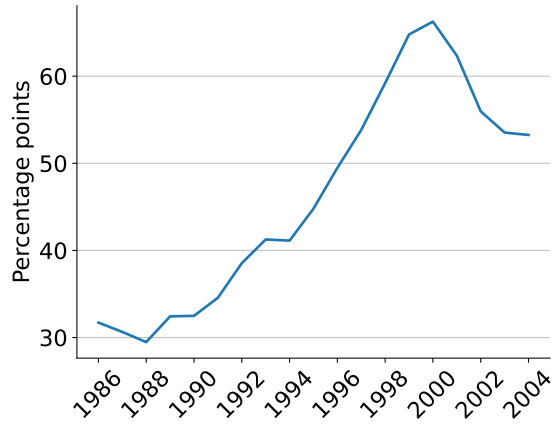
(b) Corporate profits (real, growth-adj.)



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

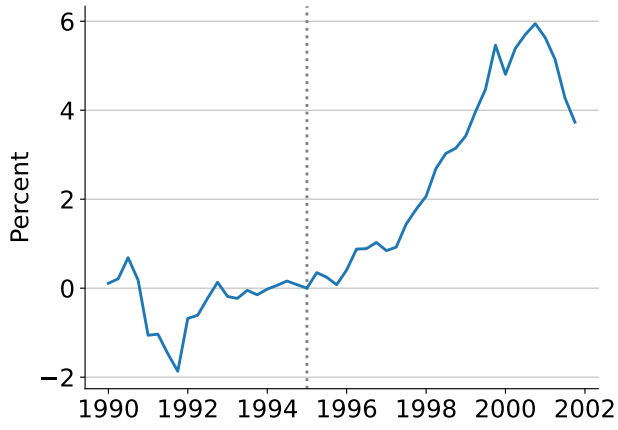


(d) Share of Stocks in liquid assets

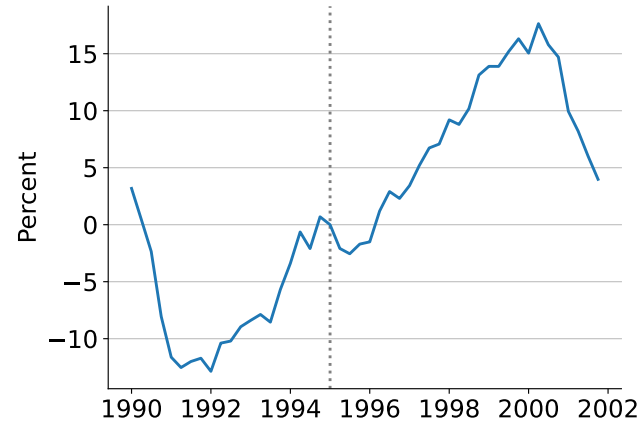


Empirical data series (business cycle)

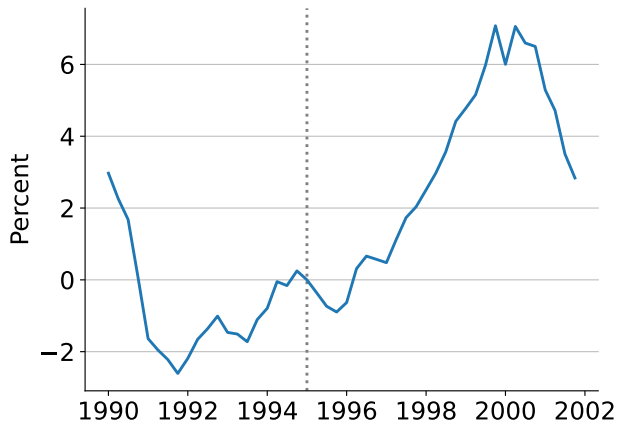
(a) Consumption (real, growth-adj.)



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



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



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