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)

My explanation hinges on *incomplete markets* and *heterogeneous agents*

- two sorts of capital: public equity, liquid, and private equity/capital, illiquid
- heterogeneous exposure to *illiquid* capital income risk
- equilibrium return on liquid assets fluctuates with marginal trader's need for self-insurance

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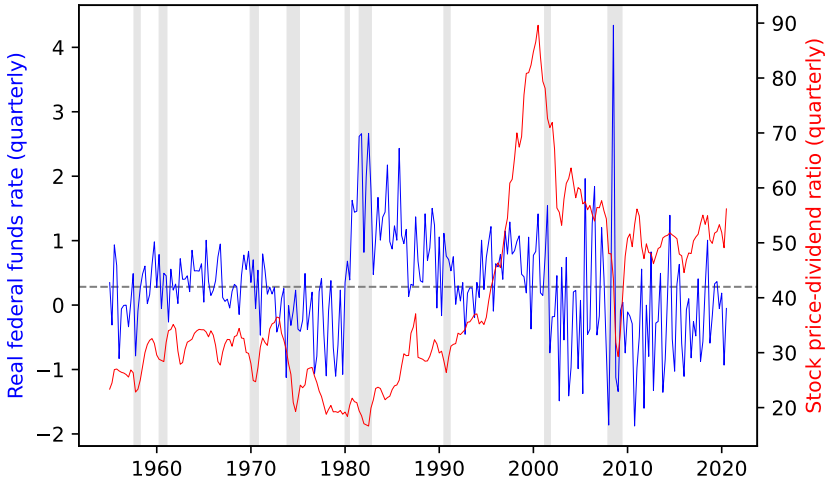
Motivation: real federal funds rate and stock market



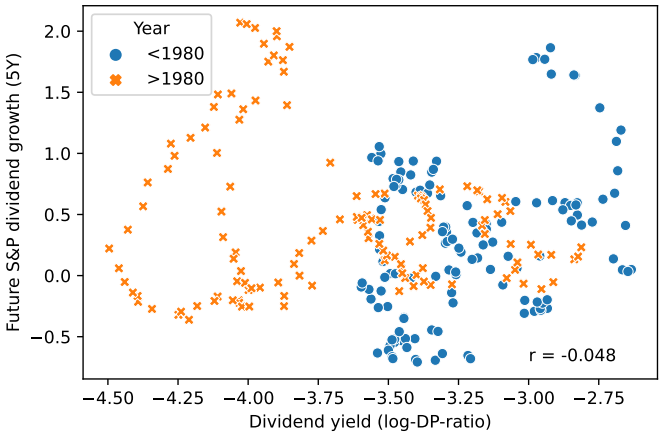
Stock market: S&P 500 data (Shiller). Shaded areas: NBER recession dates.
Dashed line: mean quarterly FFR (25 bp)

Motivation: ex-post rationalization I

Campbell and Shiller (1988):

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

Motivation: ex-post rationalization II



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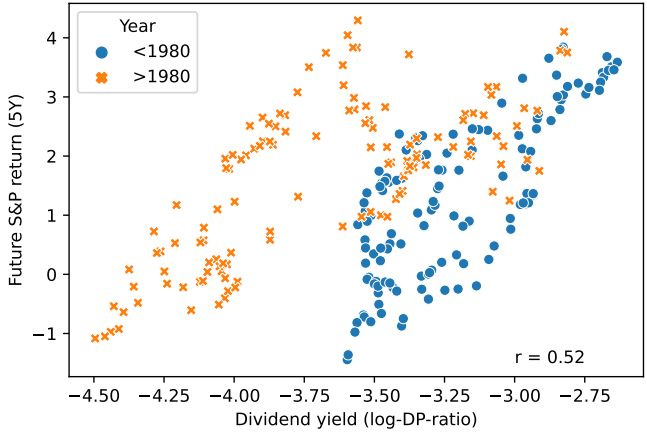

Stock market: S&P 500 data by Robert Shiller.

News-induced stock-price cycle

- news about future productivity $\rightarrow$ higher real returns today
- investment boom: rich willing to hold more illiquid capital $\rightarrow$ risk $\uparrow$
- increases *liquidity value* of holding stocks
- once capital rents fall again, rich demand 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

- **Consumption-based asset-pricing**
  Constantinides and Duffie (1996), 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), Fernández-Villaverde et al. (2020)
- **News literature**
  News generate business cycle booms in New Keynesian model (Christiano et al., 2010), with financial accelerator (Görtz et al., 2022)

Outline

Simple model

Two agent endowment economy

- Households receive high (h) or low (l) endowment each period
  $\rightarrow$ income risk
- There are liquid and illiquid assets ("capital")
- There is an ad-hoc borrowing constraint on liquid assets
- Liquid asset return R_t (ex ante), illiquid capital rent d_t
- Two household types:
  1. no capital holding, perfectly ensured against income risk
  2. high capital wealth, but cannot trade Arrow securities against income risk
     $\rightarrow$ need for self-insurance in liquid assets

$\rightarrow$ Idea: isolate illiquid capital income risk of type 2 ("rentiers")

Equilibrium conditions

Return on liquid assets R_t determined in equilibrium:

$$\frac{1}{R_t} \geq \mathbb{E}_t^i \left[SDF_{t+1}^i \right] \ \forall \ i, \tag{2}$$

where SDF^i is stochastic discount factor of hh i

- Type 1 households with $SDF = \beta$
- Type 2 households with positive liquid savings $\tilde{b}$ *marginal traders*, price R_t
- Other type 2 households are at borrowing constraint $\underline{b}$

Steady state wealth-income distribution with 4 mass-points of rentiers (Challe and Ragot, 2016):
$(\tilde{b}, h), (\underline{b}, h), (\tilde{b}, l), (\underline{b}, l)$

Experiment I

In $t = 0$:

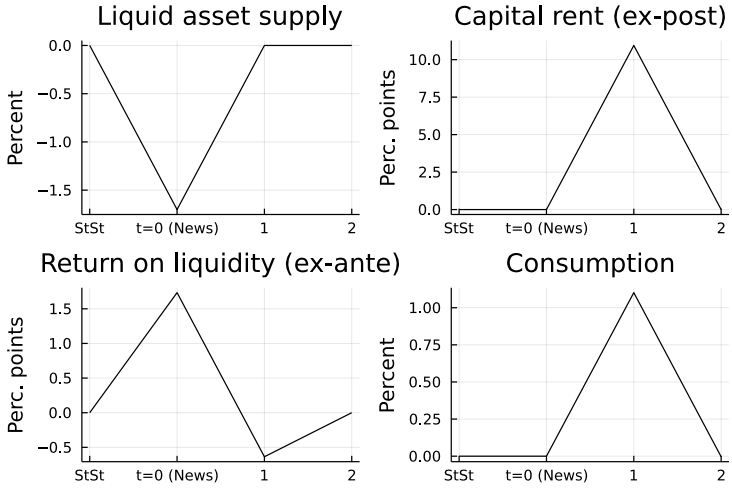
- News about capital rent increase $d_1 \uparrow$
- $\Rightarrow$ SDF of rentiers $\downarrow$, demand for liquid assets $\downarrow$
- For market clearing: $R_0 \uparrow$, liquid asset supply $\downarrow$

In $t = 1$:

- Rentiers consume more, type 1 no change
- Expectation of capital rent decrease, $d_2 \searrow \overline{d}$
- Rentiers with low endowment have higher *capital* income $\rightarrow$ can save
- $\Rightarrow$ for self-insurance, rentiers drive R_1 down, below steady state

In $t = 2$ back to steady state

Experiment II



General case: tradable capital

Intuition behind liquid return fluctuation carries over to general case:

- capital k tradable with probability λ at price q
- Gross return R^K, vs gross return on liquid assets, R^L

It holds that (without aggregate risk)

$$\text{illiquidity premium } ILP_t := R_t^K - R_t^L \geq \beta(1-\lambda)\frac{\mathbb{E}\left[\gamma_{t+1,i}\right]}{u'(c_{t,i})q_t}, \tag{3}$$

$\gamma_i := q_t u'(c_t^{i,n}) - \beta\,\mathbb{E}_t^i\, V_{t,k}^{i'}(b_t^{i,n}, k) =$ shadow price of selling capital

- Technology news $\rightarrow$ expected incomes $\uparrow$ & exp. shadow price $\downarrow \rightarrow ILP \downarrow$
- Capital rents $\searrow \rightarrow$ exp. rentiers' incomes $\downarrow$ & exp. shadow price $\uparrow \rightarrow ILP \uparrow$

Full HANK model

Household optimization

Household i solves

$$\max_{k_{it+1}, b_{it+1}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_{it}, n_{it}) \tag{4}$$

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
- h_{it} idiosyncratic productivity

Production sector

- Intermediate goods firms have technology

$$Y_t = A_t N_t^{1-\alpha_t} (u_t K_t)^{\alpha_t} \tag{5}$$

- α_t capital share of production, with

$$\alpha_t = (1 - \rho_\alpha)\overline{\alpha} + \rho_\alpha \alpha_{t-1} + \epsilon_{t-\ell}^{\alpha,\ell} + \epsilon_t^{\alpha} \tag{6}$$

- $\epsilon_{t-\ell}^{\alpha,\ell}$ news shock, known ℓ periods in advance
- (results robust to TFP-news shock)

- Final goods firms: monopolistic competition, Calvo-price stickiness
- Smoothed profits $\Pi_t^F = (\mu_t - 1) Y_t$ payed to entrepreneurs
- Distribute fraction ω^{Π} as stock asset dividend div_t

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Factor and Profit incomes

	labor income	firm profits Π^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/π_t	$(q_t^\Pi + div_t)/q_{t-1}^\Pi$	-
illiquid asset k_i	-	-	$R^k := (q_t + r_t)/q_{t-1}$

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

$$c_{it} + b_{it+1} + \mathbb{I}_{\{k' \neq k\}} q_t (k_{it+1} - k_{it}) \leq h_{it} N_t W_t + \mathbb{I}_{\{entr\}} \Pi_t^F + R_t^L b_{it} + r_t k_{it} \quad (7)$$

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Government sector

- Taylor rule

$$\frac{R^b_{t+1}}{\bar{R}^b} = \left(\frac{R^b_t}{\bar{R}^b}\right)^{\rho_R} \left(\frac{\pi_t}{\bar{\pi}}\right)^{(1-\rho_R)\theta_\pi} \left(\frac{Y_t}{Y^*_t}\right)^{(1-\rho_R)\theta_Y} \tag{8}$$

- Fiscal rule

$$\frac{B_{t+1}}{B_t} = \left(\frac{B_t}{\bar{B}}\right)^{-\gamma_B} \left(\frac{\pi_t}{\bar{\pi}}\right)^{-\gamma_\pi} \left(\frac{Y_t}{Y^*_t}\right)^{-\gamma_Y} \tag{9}$$

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

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

Mapping: Household portfolio $\rightleftarrows$ 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 Asset-classes (baseline)
  - HANK with One Asset-class (capital liquid)
  - RANK

  where time-discount factors β calibrated such that $R^L = 2.5\%$ in all models

- "Only Noise": all news are disappointed ($\alpha_t = \overline{\alpha}$)

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Simulation: stock returns and the business cycle

Variables	Data	(I)	(II)	(III)	(IV)	(V)
$mean(P/D)$	152*	151	148	147	146	149
$\sigma(P/D)$	63	48	35	28	28	42
$\rho(P/D)$	0.98	0.986	0.985	0.99	0.996	0.96
$\rho(\Delta P/D)$	0.99	0.11	0.01	0.41	0.41	-0.04
$\sigma(\Delta D)$	1.75%*	1.74%	1.27%	1.81%	1.49%	1.46%
$\rho(I/Y, P/D)$	15.2%	62%	32%	-5%	-24%	41%
$\rho(\Delta I/Y, \Delta P/D)$	17.5%	34%	29%	4.8%	-22%	64%
$\rho(\Delta C/Y, \Delta P/D)$	15.4%	2.1%	-58%	7.9%	-72%	64%
$\rho(R^b/\pi, R^{stocks})$	0.13-0.19	0.24	0.24	0.05	-0.11	0.3
$\sigma(R^{stocks})$	7.28%	5.07%	4.27%	1.63%	1.45%	7.84%
$\sigma(R^{stocks})/\sigma(R^b/\pi)$	1.7-8.9	2.9	5.3	3.7	4.26	12.2

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Simulation: Campbell-Shiller decomposition

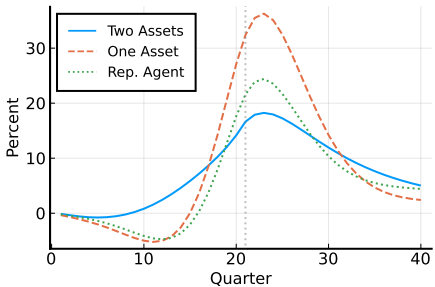
Regress on today's price-dividend ratio (Cochrane, 2011):

- sum of future dividend growth
- $-$ (minus) sum of future stock returns
- future price-dividend ratio

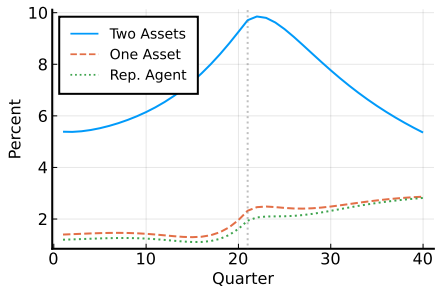
Spec	Dividends	Returns	PD-ratio
Data	0.11	1.01	0.11
Baseline	0.39	0.52	0.08
One-Asset	0.97	-0.04	0.07
No News	0.29	0.44	0.28
Only Noise	0.25	0.57	0.18

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*)



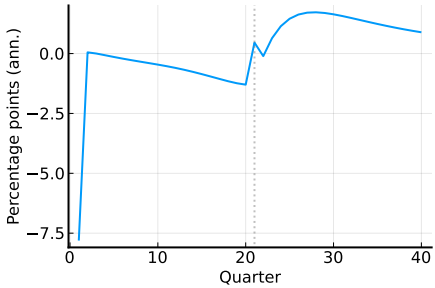
(a) Investment



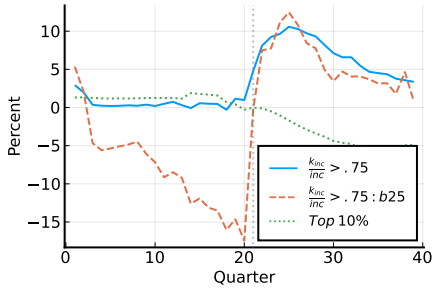
(b) Stock price

More IRFs

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

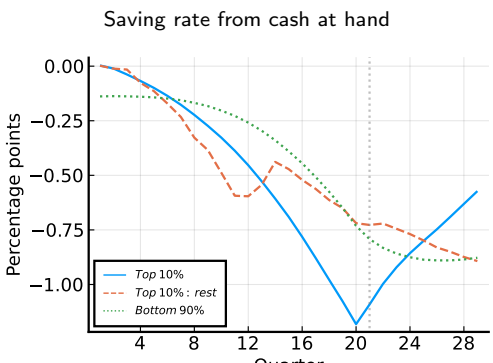
- Heterogeneity allows identification of marginal saver: households with income dominated by capital rents
- increase consumption risk in anticipation phase Theory

Marginal savers in full model: evidence

"rest": households who have *not*

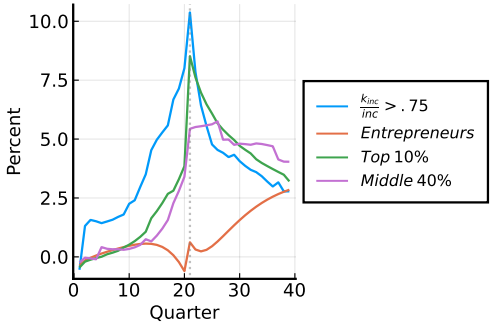
- been wealthy hand-to-mouth in $t \geq 0$
- became unconstrained in $s > t$

$$\text{cash at hand}_{it} = y_{it} + b_{it} R_t^L / \pi_t + k_{it}(r_t + \mathbb{1}_{\{k \text{ adjustable}\}} q_t) - \underline{B}$$

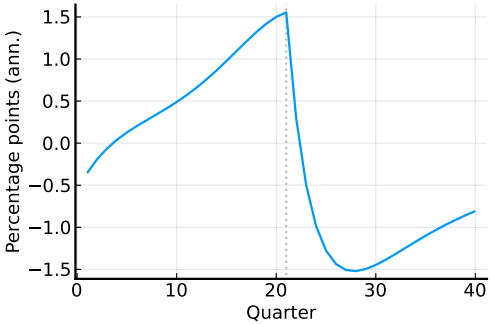


Marginal savers in full model: optimality

(a) Income across groups



(b) Borrowing rate



Income and GE-price effects → "rentiers" become wealthy hand-to-mouth

Monetary and fiscal policy

Results go through without price-stickiness
$\rightarrow$ monetary policy largely unimportant plots

Importance of fiscal rule:

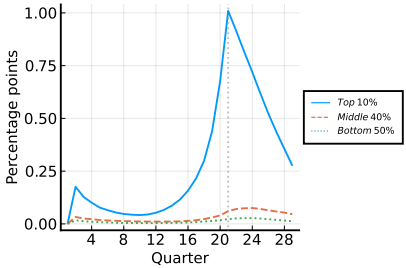
- lower demand for liquid assets in the anticipation phase (expected higher income)
- no bond supply reduction $\rightarrow$ inflation
- $\rightarrow$ investment boom *inhibited*: rich households with high marginal propensities to invest lose

$\rightarrow$ positive news can be *harnessed* by government to have more productive, i.e. illiquid, portfolios

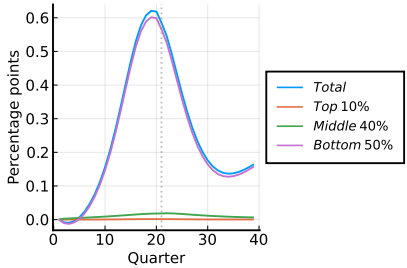
plots

Intensive vs extensive margin of capital holding

(a) Wealthy hand-to-mouth share



(b) No-capital share



- investment-boom driven by *intensive* margin of wealthy households
- bottom 50% buy capital *after* boom, when illiquidity premium high

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

Evidence from Microdata

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

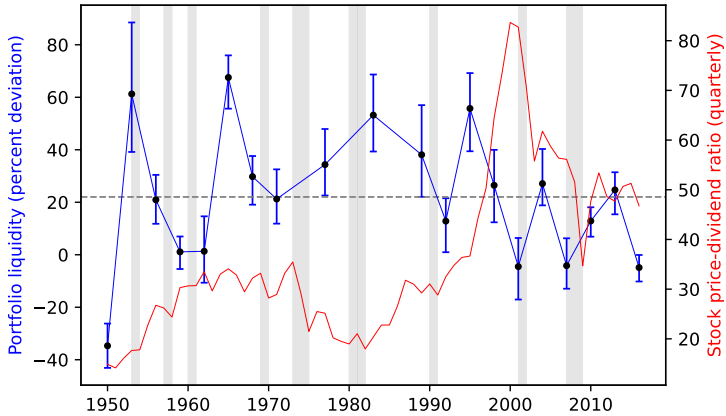
$$\Delta_i \frac{q^{\Pi}}{d} = \sum_g \beta_g \Delta_i \text{pflq}^g + \epsilon_i,\ i = 1, .., 19$$

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 (Shiller). *Whiskers*: 68% CIs

SCF: Who are the "rentiers"?

- 68% self-employed, managers/professionals
- most are in top 10% of wealth and income-distribution
- 42% of wealth is in business wealth
- income from self-employment not so high, but asset income very high

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

- channel should become *more* important in boom: higher stock-shares in boom imply higher risk premia, lowering stock prices
- Analyze heterogeneous stock shares: aggregate and welfare implications

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Appendix

Theory: Consumption-based asset pricing with het. agents

I show that (without aggregate risk)

$$ILP_t := R_t^K - R_t^L \geq \beta(1-\lambda)\frac{\mathbb{E}_t\left[\gamma_{t+1,i}\right]}{u'(c_{t,i})q_t} \tag{10}$$

for all households i
$\gamma_i :=$ shadow price of selling capital

Implications:

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

back

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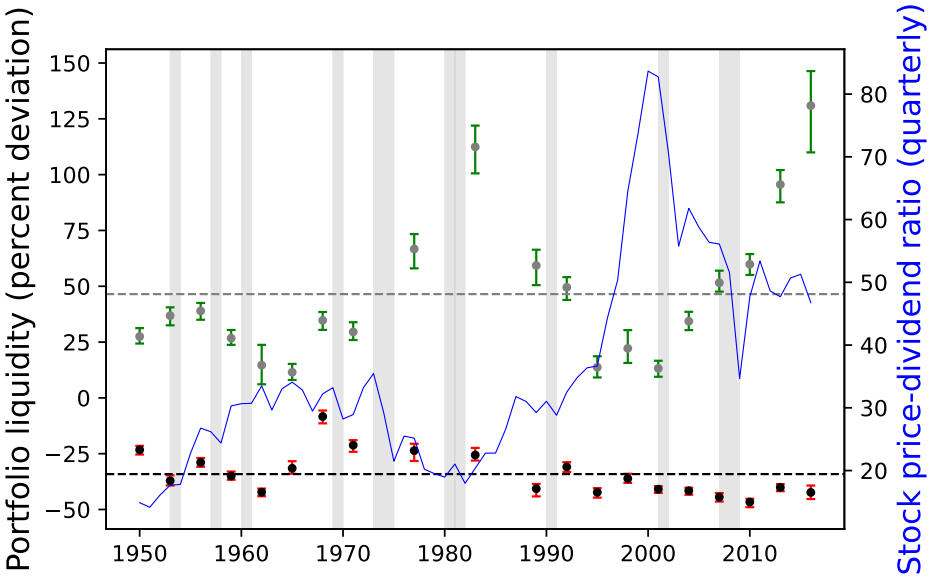
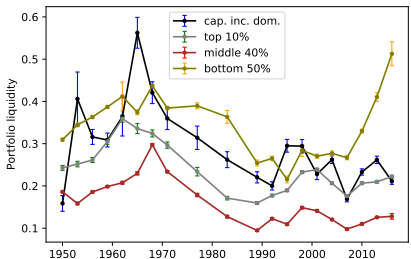
back

Relative portfolio liquidity of bottom 90%

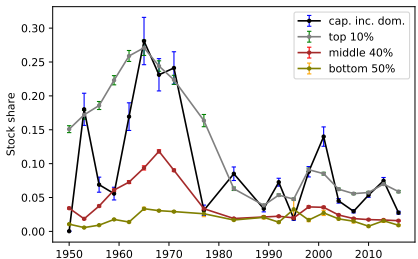


Survey of Consumer Finances: Heterogeneous Portfolios I

(a) Portfolio liquidity



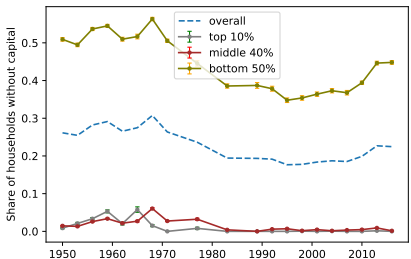
(b) Stock shares



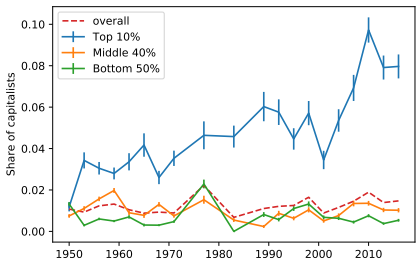
Source: SCF+ (Kuhn et al., 2020)

Survey of Consumer Finances: Heterogeneous Portfolios II

(a) Households without capital



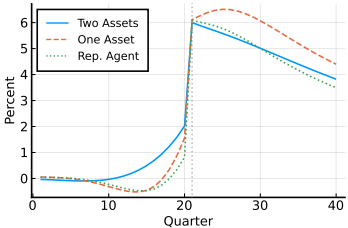
(b) Households with high capital income



back

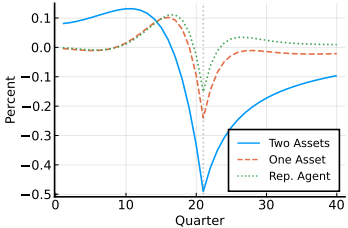
Impulse responses to news shock

back

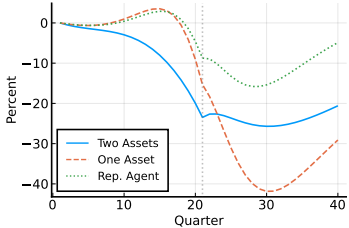


(a) Output

(b) Consumption



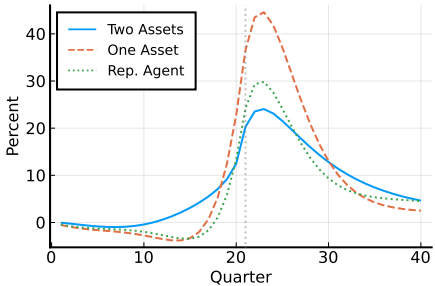
(c) Inflation



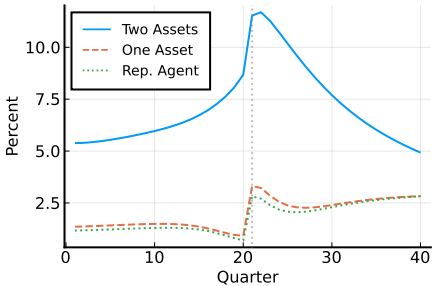
(d) Goverment bonds

No price stickiness

back



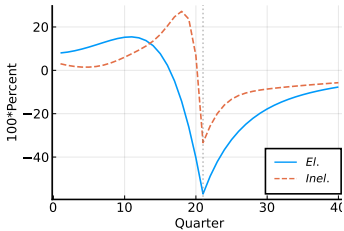
(a) Investment



(b) Stock price

Importance of liquid asset supply elasticity

back



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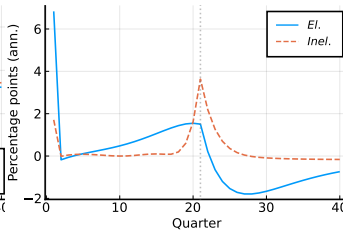
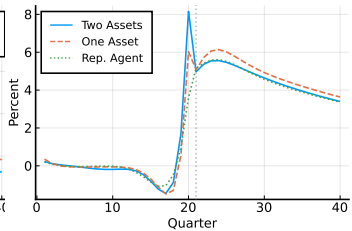


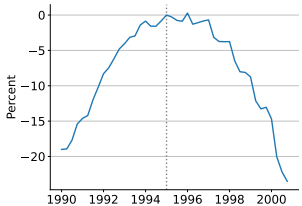
(b) Real liquid return



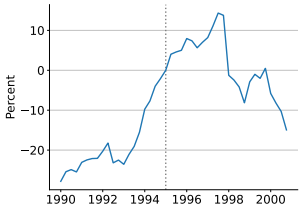
(c) Output (Inel.)

Empirical data series

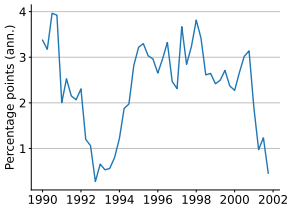
(a) Federal debt (real, growth-adj.)



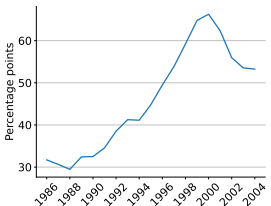
(b) Corporate profits (real, growth-adj.)



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

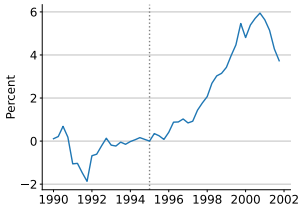


(d) Share of Stocks in liquid assets

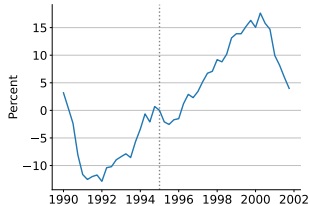


Empirical data series (business cycle)

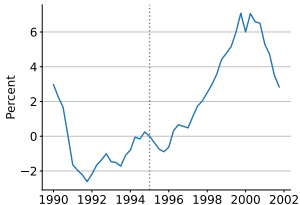
(a) Consumption (real, growth-adj.)



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



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



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