Sources of U.S. Wealth Inequality in the Past, Present, and Future

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Formerly "A Comprehensive Quantititative Theory of the U.S. Wealth Distribution";
before that, "The Historical Evolution of the Wealth Distribution: A Quantitative-Theoretic Investigation"

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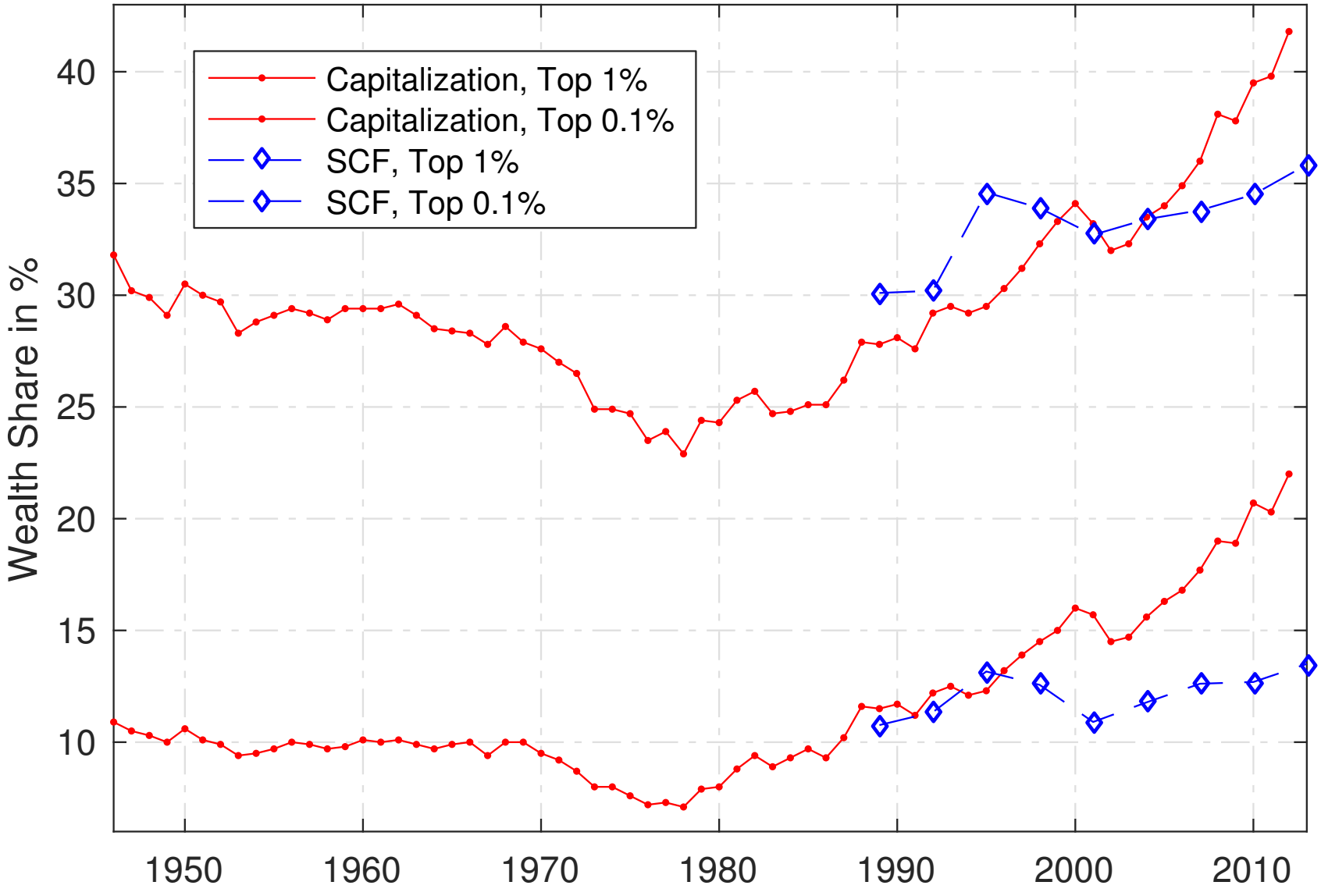
Macroeconomics and inequality

inequality has become a major part of macroeconomics

- significant recent public interest in inequality
- significant recent academic interest in how inequality affects macroeconomic aggregates:
  - affects average MPC, and hence fiscal and monetary multipliers
  - affects the distribution of MPCs, opens up for state dependence
  - affects distribution of marginal propensities to work too
- idea here: evaluate our new workhorse of macro and inquality—the Bewley/Huggett/Aiyagari model—from the perspective of U.S. data on wealth inequality

Evolution of top wealth inequality in the U.S.



Data: Kopczuk 2015, Saez & Zucman 2016.

Overview: objective

- examine the workhorse model quantitatively: can it match the data?
  - its average shape
  - its evolution over time
- in particular, study the role of a number of wealth-inequality determinants: marginal tax rates, preferences, earnings, and portfolio returns—all varying across households and over time
- we tie all of the parameters to micro data; does the benchmark framework do an adequate job?

Overview: findings

- average shape:
  - yes
  - due to portfolio heterogeneity, very small (or no) role for preference heterogeneity
- dynamic evolution:
  - yes, except for very, very top
  - lower tax progressivity plays key role for cumulative
  - portfolio heterogeneity and asset prices key for swings
  - earnings variance plays little role
- predictions for future: slow but significant further widening of inequality

Quantitative incomplete-markets model

- extended Aiyagari 1994 framework (optimal growth model, idiosyncratic wage shocks, precautionary saving):
  - log labor income as sum of persistent and transitory component; adjusted at the top to match the observed Pareto tail in labor income
  - transitory component incorporates zero earnings state
  - heterogeneous returns: reduced-form portfolio choice, returns increasing in wealth and have i.i.d. idiosyncratic component
  - stochastic discount factor follows AR(1) process (Krusell-Smith 1998 extended)
  - progressive taxation: use data on federal effective tax rates for 11 income brackets (Piketty & Saez 2007)
  - parsimonious modeling of social safety net: 60% of tax revenues rebated as lump-sum transfers
- time-varying taxes, labor income process, and excess returns
- finding: saving rates (key consumer choice) very robust and unresponsive to all drivers

Return heterogeneity

- total return given asset holdings a_t is

$$\underline{r}_t + r_t^X(a_t) + \sigma^X(a_t)\eta_t$$

- $\underline{r}_t$ is endogenous
- $r_t^X(\cdot)$ and $\sigma^X(\cdot)$ are exogenous excess return schedules (mean and st.dev.), taken from the data
- η_t is an i.i.d. standard normal shock
- rationalize as reduced form of portfolio choice model

The consumer's problem

$$V_t(x_t, p_t, \beta_t) = \max_{a_{t+1} \geq \underline{a}} \{u(x_t - a_{t+1}) + \beta_t \mathbb{E}\left[V_{t+1}(x_{t+1}, p_{t+1}, \beta_{t+1}) | p_t, \beta_t\right]\}$$

subject to:
$$x_{t+1} = a_{t+1} + y_{t+1}^{ord} - \tau_{t+1}^{ord}(y_{t+1}^{ord}) + (1 - \tau_{t+1}^{cg}) y_{t+1}^{cg} + T_{t+1}$$
$$y_{t+1}^{ord} = (\underline{r}_{t+1} + r_{t+1}^{X}(a_{t+1}))a_{t+1} + w_{t+1} l_{t+1}(p_{t+1}, \nu_{t+1})$$
$$y_{t+1}^{cg} = \sigma^{X}(a_{t+1})\eta_{t+1} a_{t+1}$$

x_t cash on hand

$l_{t+1}(\cdot, \cdot)$ efficiency units of labor, moves over time

—p_t persistent component of earnings process

—ν_{t+1} transitory earnings shock

$\tau_t^{ord}(\cdot)$ progressive tax on ordinary income, moves over time

τ_t^{cg} flat capital gains tax, moves over time

T_t lump-sum transfer

Whence wealth inequality?

- a dynasty model with complete markets, identical (standard) preferences and returns: generates no long-run wealth inequality beyond initial conditions $=>$ inadequate model of wealth inequality
- incomplete markets added: has predictions, i.e., generates unique distribution in steady state
- Aiyagari (1994) delivers far too little wealth inequality: Gini of wealth becomes that of earnings (in data: $>>$)
- the literature has struggled with this (no clear consensus)
  - finite lives/OG?
  - preference heterogeneity
  - returns increase with wealth, entrepreneurs
  - different earnings processes
- here:
  - no "tricks": just feed in micro observations, works well
  - portfolio heterogeneity important but next step is to explain it!

Nontrivial mechanisms at top of the distribution

- in the data, both earnings and wealth distribution have Pareto shapes at the top
  - again, wealth has a fatter tail (lower Pareto coefficient)
- we calibrate earnings as in Aiyagari but add Pareto distribution at the top—calibrated to data
  - this generates Pareto in wealth but with same coefficient $=>$ too thin a tail
- however: stochastic returns or βs generate a Pareto tail in the wealth distribution endogenously!
  - follows from random growth theory (Kesten 1973, see also Gabaix 2009)
  - mechanism has been employed by Benhabib, Bisin and Zhu 2015, Nirei & Aoki 2015, Piketty & Zucman 2015

Calibration strategy

1. calibrate earnings process, tax rates, return process, social safety net to observables
2. choose randomness in discount factor residually so as to replicate the wealth distribution in the initial steady state (1967)

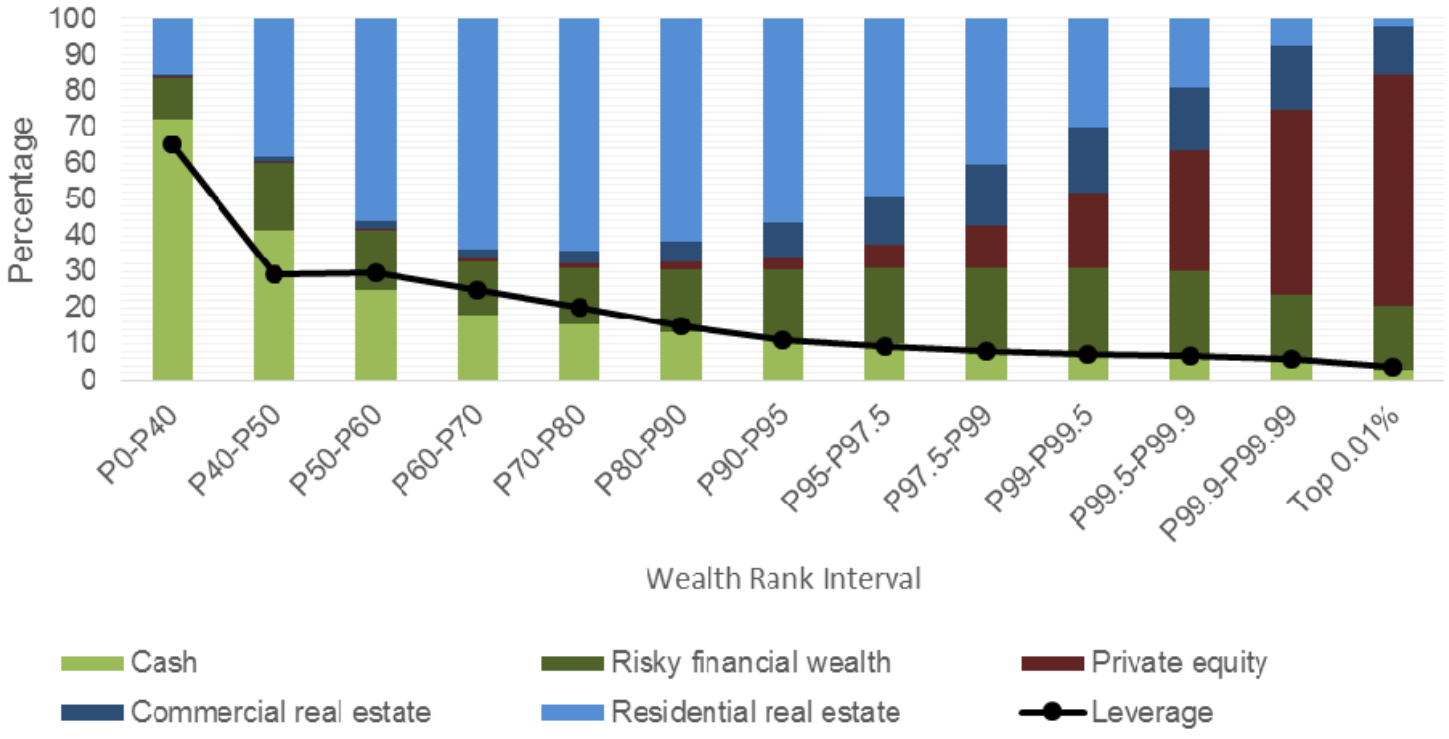
Calibration: return process

$$r_t^X(a_t) = \sum_{c \in C} w_c(a_t) \left(\bar{r}_{c,t} + \tilde{r}_c^X(a_t) \right)$$

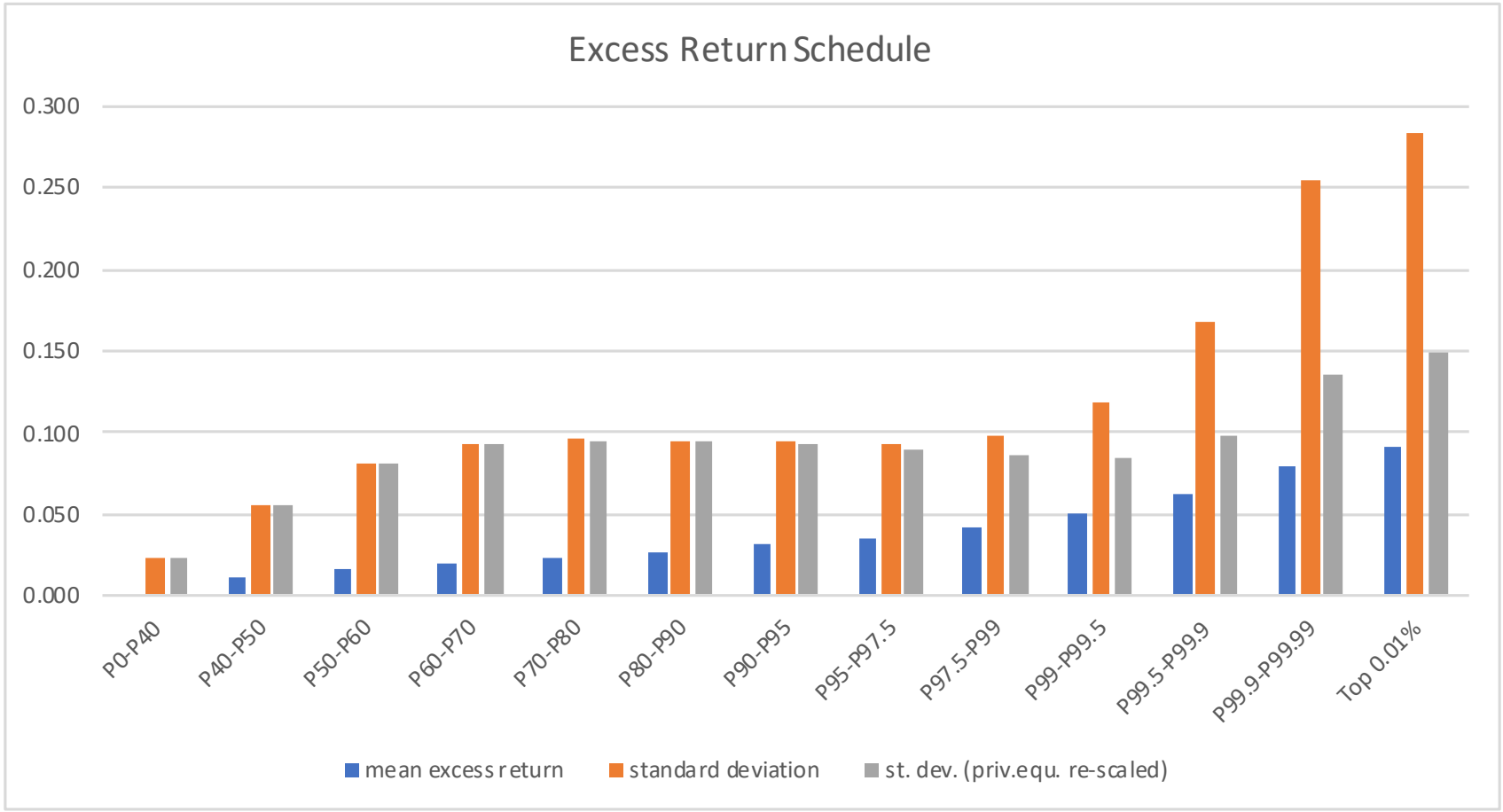
$$\left(\sigma^X(a_t) \right)^2 = \sum_{c \in C} \left(w_c(a_t) \tilde{\sigma}_c^X(a_t) \right)^2$$

- asset classes C: risk-free, public equity, private equity, housing
- $\bar{r}_{c,t}$: aggregate return on asset class c (U.S. data), time-varying
- fixed over time, based on Swedish administrative data from Bach, Calvet, Sodini (2016):
  - $w_c(\cdot)$: portfolio weights
  - $\tilde{r}_c^X(\cdot)$: within asset class return heterogeneity
  - $\tilde{\sigma}_c^X(\cdot)$: asset c idiosyncratic return standard deviation

Portfolio holdings



Excess return schedule



Calibration: stochastic-β and other

Single-β model:

- no β-heterogeneity
- returns as measured in the data

Stochastic-β model (benchmark):

- β_t follows AR(1) process with: $\mu = 0.94$, $\rho = 0.992$, $\sigma = 0.0006$
- in cross-section, standard deviation $= 0.005$; over 50 years, mean reversion is $1/3$
- re-scale standard deviation of private equity return by 0.52

Other:

- CRRA $= 1.5$
- zero earnings with prob 0.075
- borrowing constraint at level of annual transfer
- Cobb-Douglas with capital's share $= 0.36$; $\delta = 0.048$

Results, I: steady state (1967)

	Top 10%	Top 1%	Top 0.1%	Top 0.01%
Data*	70.8%	27.8%	9.4%	3.1%
Single-β Model	66.6%	23.7%	11.2%	7.2%
Benchmark Model	73.8%	27.4%	8.4%	3.2%
	Bottom 50%	Fraction $a < 0$		
Data*	4.0%	8.0%		
Single-β Model	3.5%	7.3%		
Benchmark Model	3.0%	6.6%		

(*top wealth shares (capitalization): Saez & Zucman 2016;
bottom 50% share (SCF): Kennickell 2011)

- model also matches wealth distribution well on its entire domain

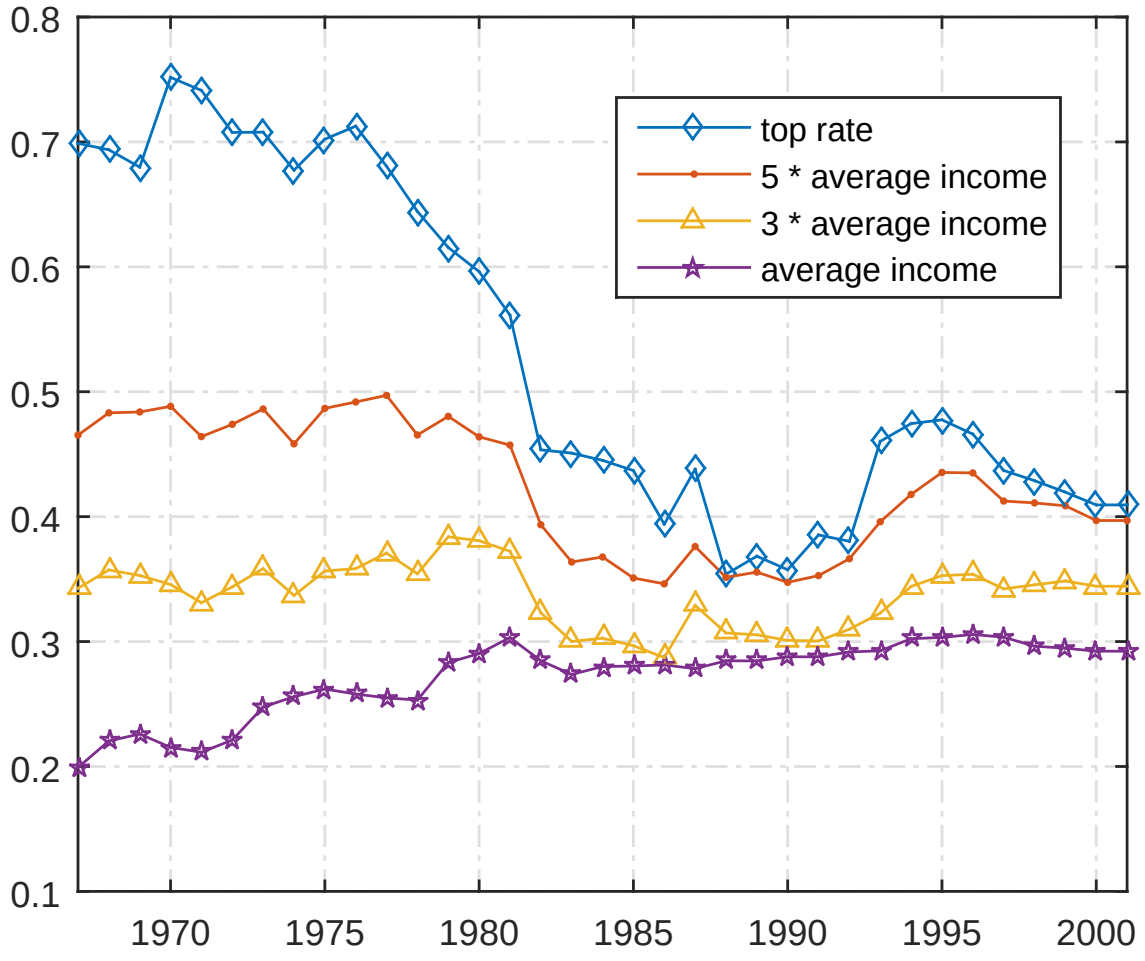
Contribution of different channels

	top 10%	top 1%	top 0.1%	top 0.01%	Gini
β-heterogeneity	8.8%	7.7%	3.8%	2.0%	0.050
earnings heterogeneity	-27.5%	-17.8%	-9.5%	-6.4%	-0.173
persistent	-5.0%	-7.5%	-4.2%	-2.9%	0.009
transitory	-11.6%	-4.3%	-1.7%	-0.9%	-0.109
tax progressivity	-21.3%	-61.8%	-71.2%	-67.1%	-0.148
return heterogeneity	29.5%	18.4%	6.6%	2.8%	0.192
mean differences	25.8%	16.7%	6.0%	2.6%	0.174
return risk	0.7%	2.2%	3.3%	2.5%	0.004

Interpretation: e.g. when removing β-heterogeneity from the benchmark model, the top 10% share decreases from 73.8% to 65.0% (in general equilibrium). Thus, β-heterogeneity contributes $+8.8$ percentage points to the top 10% wealth share.

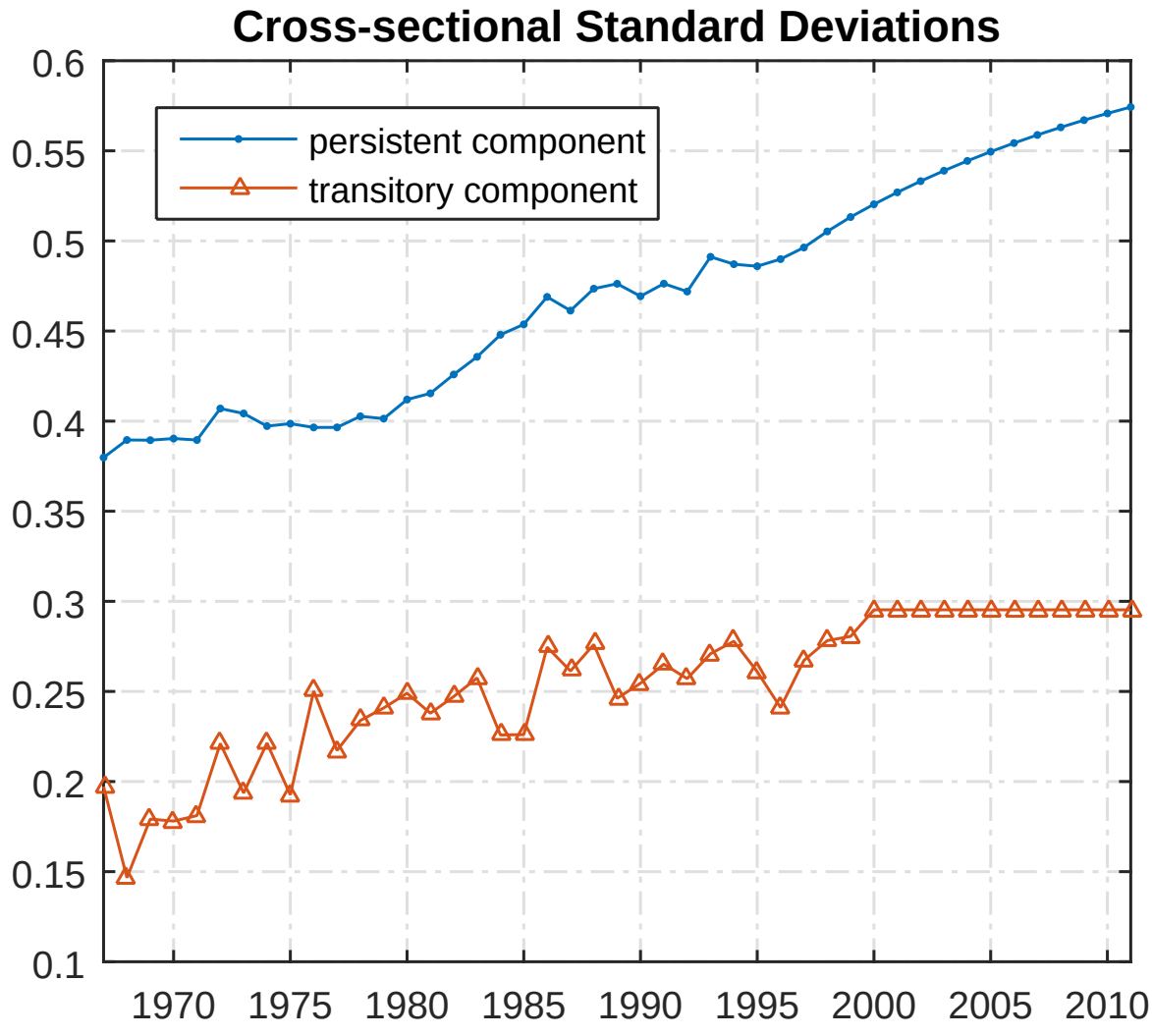
Observed change 1: decrease in tax progressivity

- federal effective tax rates (Piketty & Saez 2007): income, payroll, corporate and estate taxes



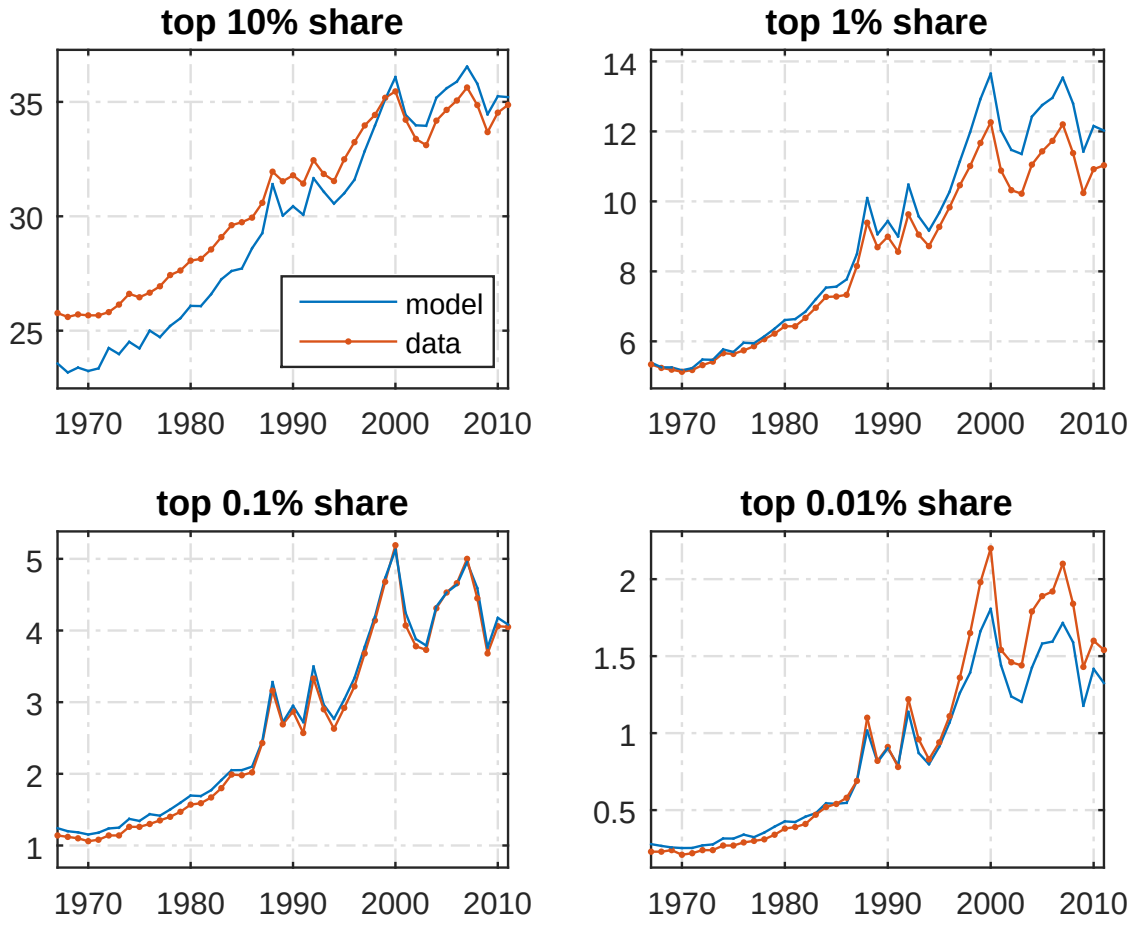
Observed change 2: increase in labor income risk

- estimates for variance of persistent and temporary components 1967-2000 (Heathcote, Storesletten & Violante 2010)

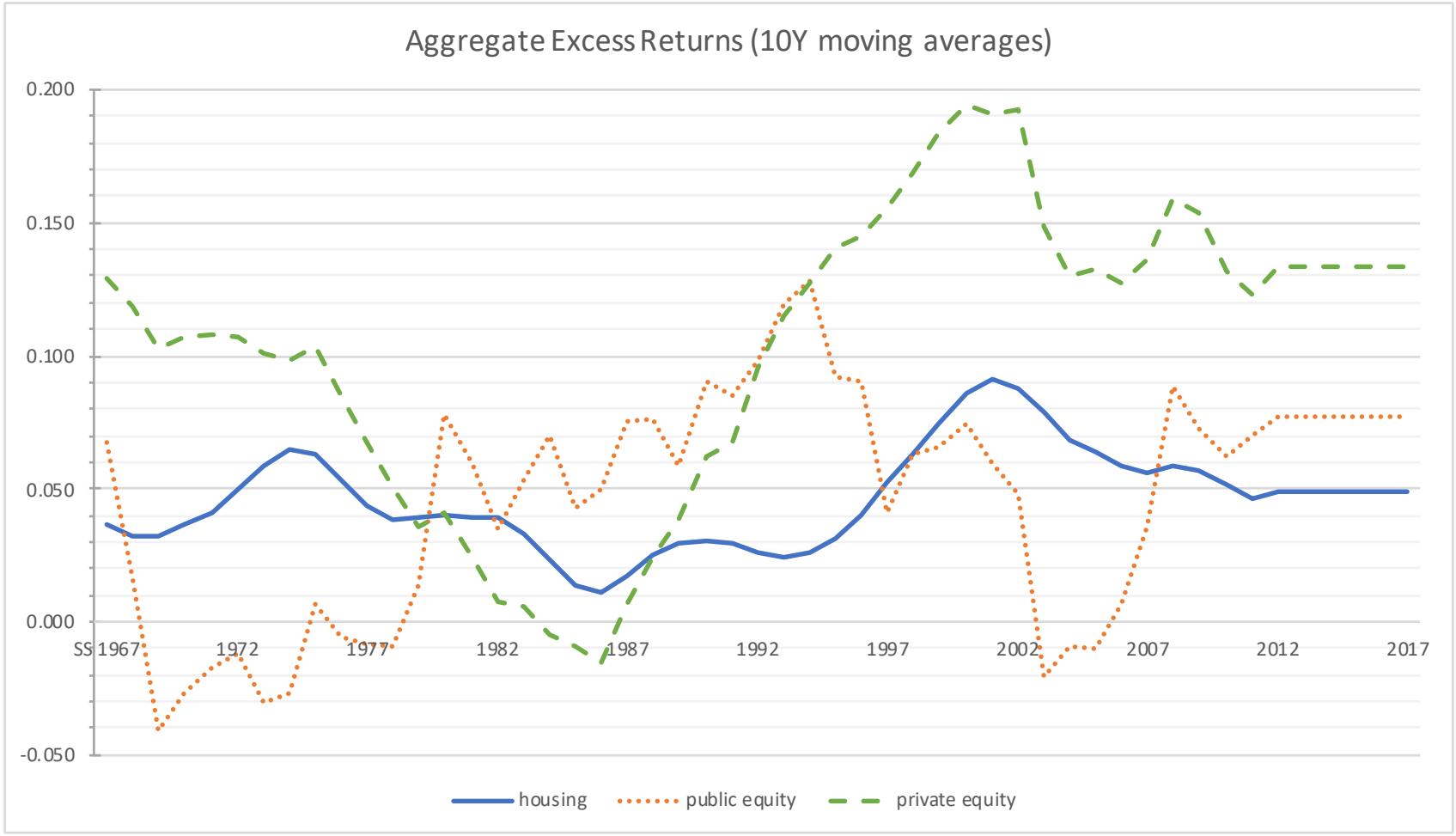


Observed change 3: increase in top labor income shares

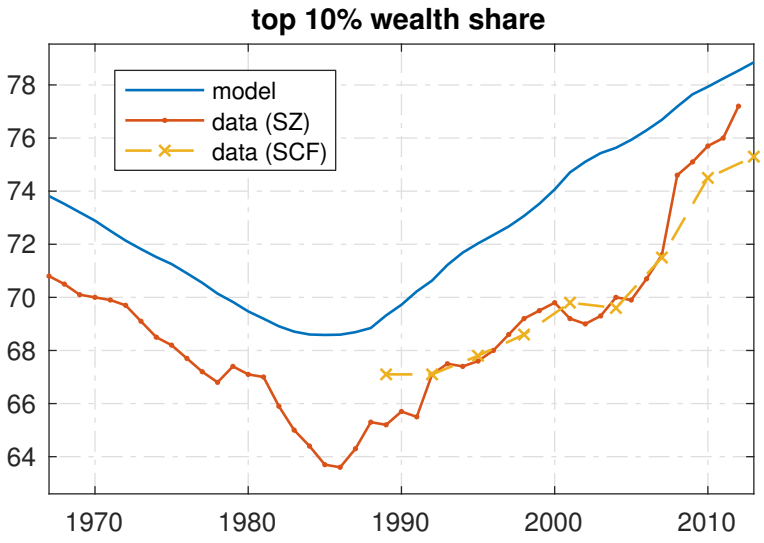
- adjust standard AR(1) in idiosyncratic productivity by imposing a Pareto tail for the top 10% earners: calibrated tail coefficient decreases from 2.8 to 1.9 (Piketty & Saez 2003, updated series in 2011)

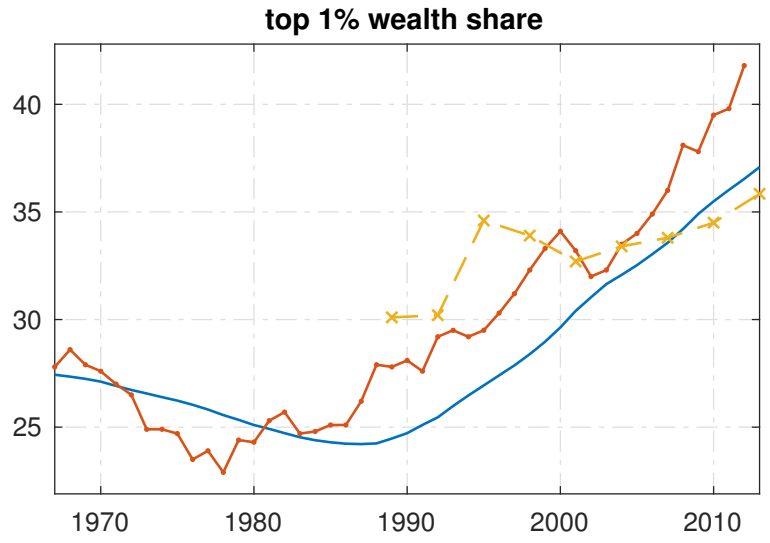


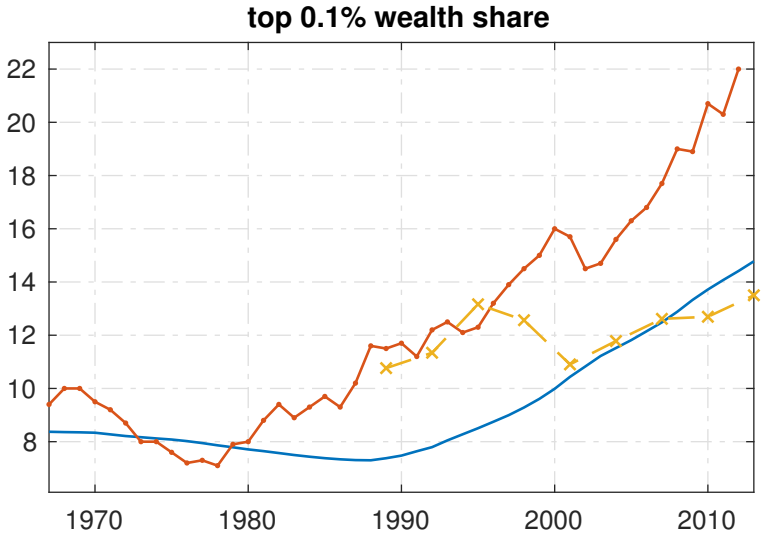
Observed change 4: valuation effects

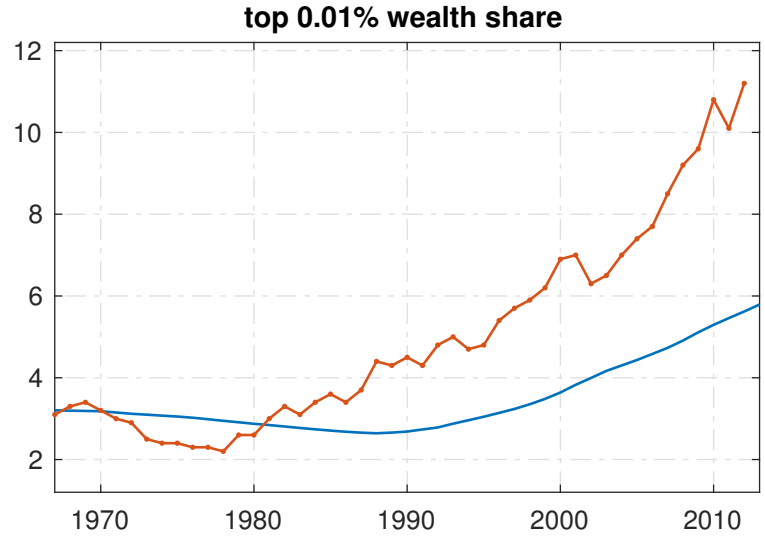


Results, II: historical evolution









Summary of transitional dynamics

- model captures the salient features of the evolution of the U.S. wealth distribution
- assumptions that we found are not critical:
  - perfect foresight (▸ details)
  - robust to CES production function with elasticity > 1 (▸ details)
- shortcomings:
  - explosion of wealth concentration at the extreme top (0.01%) as measured by Saez & Zucman 2016 not explained well

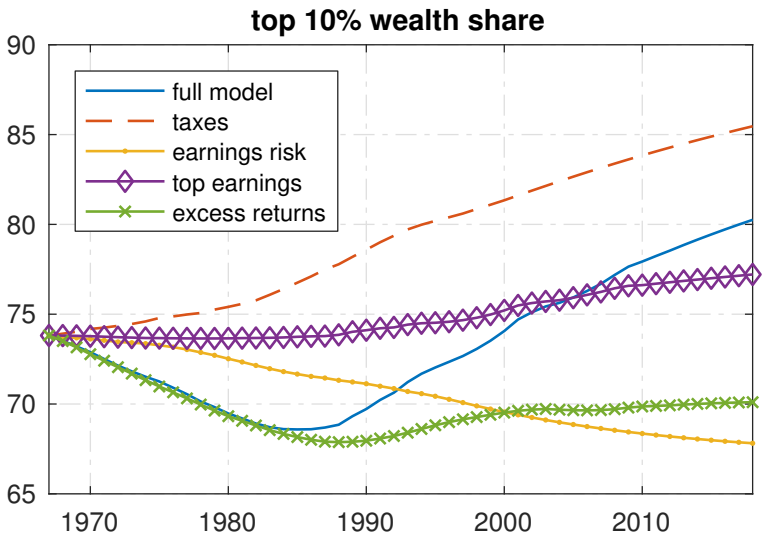
Main channels

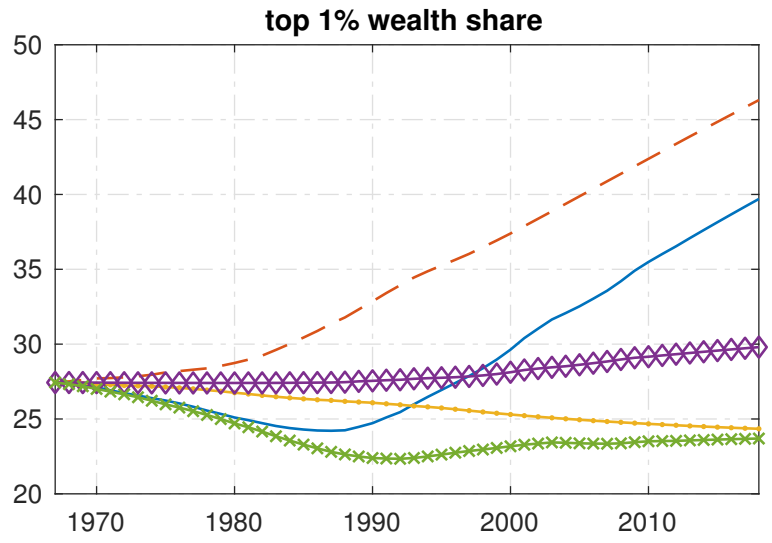
- what fraction of the cumulative increase in the top wealth shares do the four channels account for? (graphs)

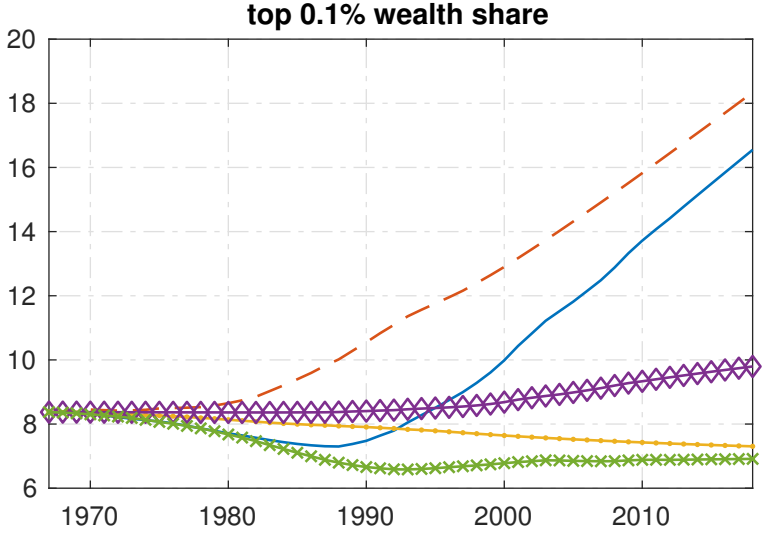
	Top 10%	Top 1%	Top 0.1%	Top 0.01%
Taxes	1.57	1.15	0.72	0.36
Top Earnings Inequality	0.44	0.14	0.10	0.06
Earnings Risk	-0.84	-0.21	-0.09	-0.05
Return Premia	-0.58	-0.28	-0.13	-0.08
Combined	0.71	0.66	0.54	0.29

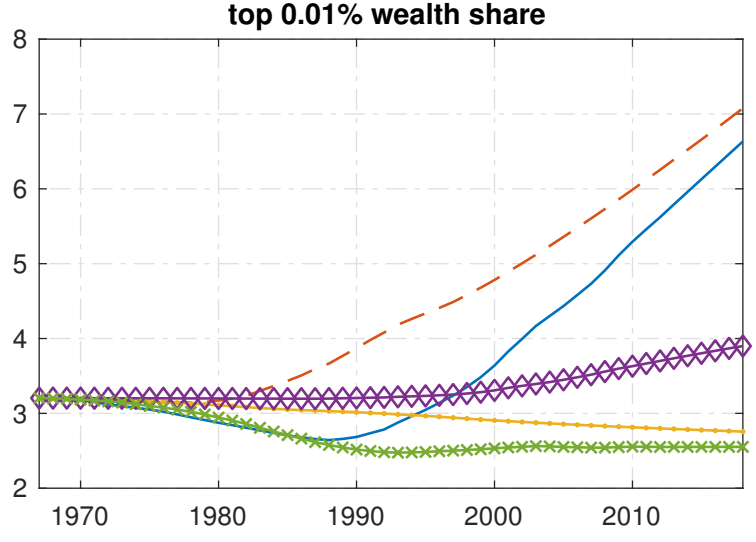
- larger earnings risk can induce higher precautionary savings
  - especially among the less wealthy, reducing tendency of heterogeneous discount factors to drive apart the wealth distribution (Becker 1980)
  - interest rate falls, thereby increasing the Pareto tail coefficient (i.e., decreasing top wealth inequality)

Decomposition of transitional dynamics

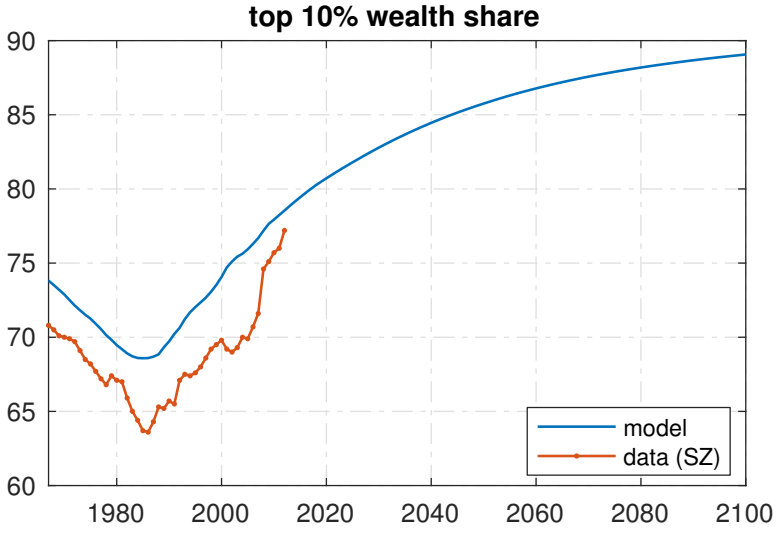


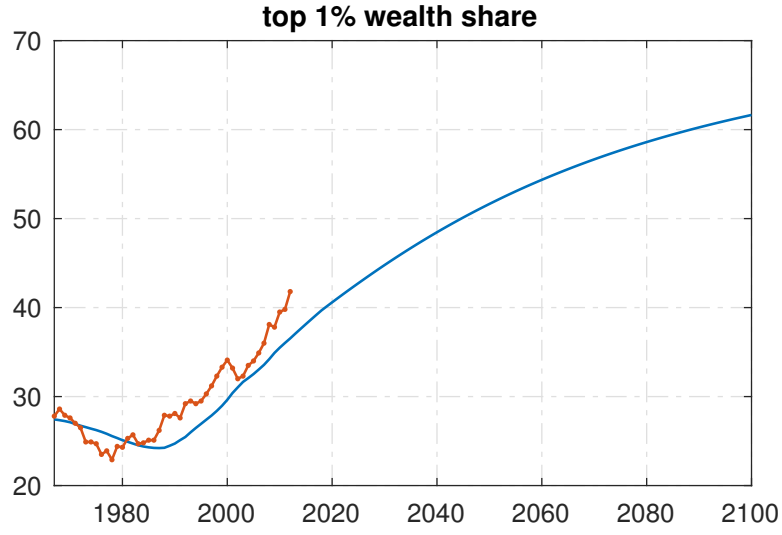


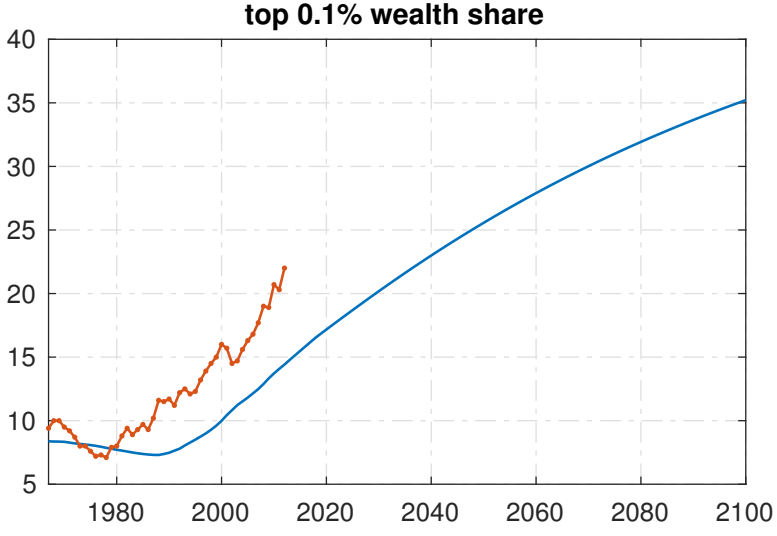


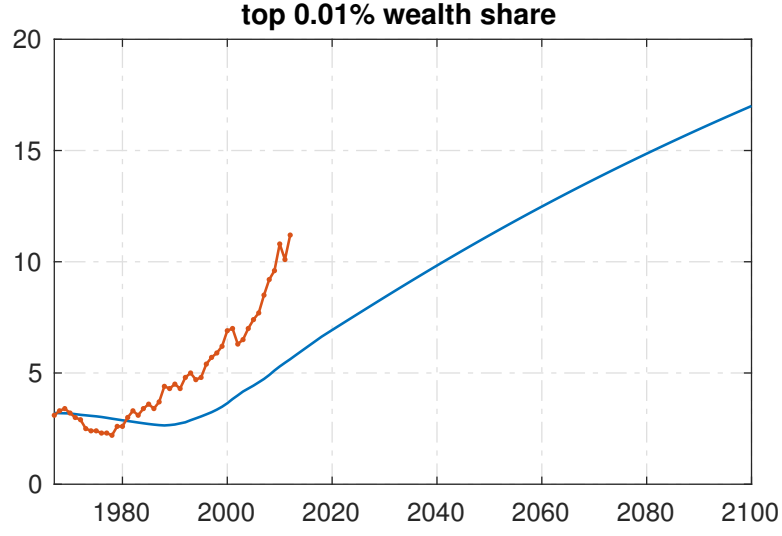


Capital in the 21st century?

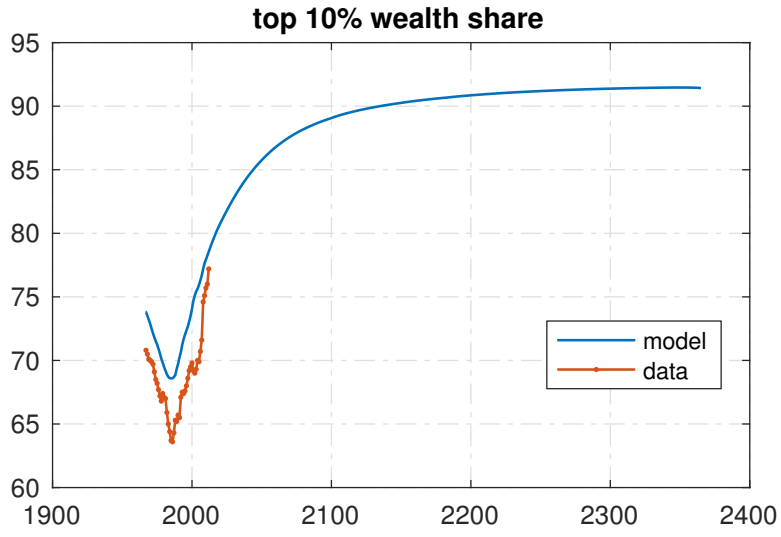


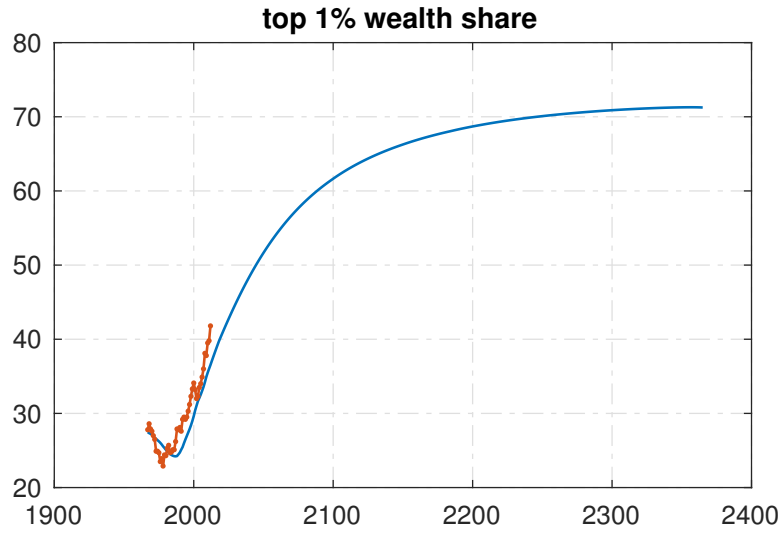


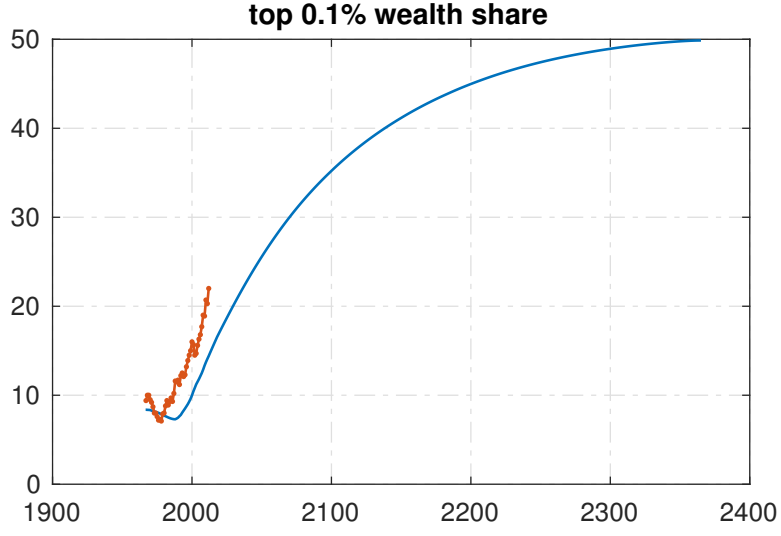


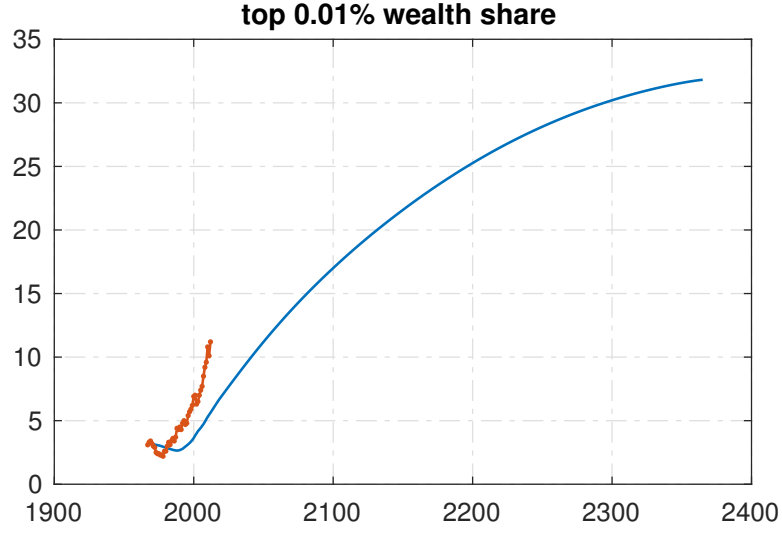


Capital in the 24th century???









Conclusion: (surprising) success, challenging new questions

- main findings, steady state:
  - need for β heterogeneity almost gone in new calibration
  - key reason: (realistic) return heterogeneity
- main findings, historical evolution:
  - declining tax progressivity most powerful force for generating increases in wealth inequality
  - asset-price movements account very well for short-run dynamics (U-shape in wealth inequality)
  - speed of changes at the very top hard to match (if you believe in Saez & Zucman data)
- remaining questions from perspective of this paper:
  - missing rise at top: increased idiosyncratic return volatility, shift toward private equity?
  - why are portfolios heterogeneous (both across and within wealth levels), what drives returns?
- implications for macro: concomitant evolution of mpcs.

dziękuję bardzo

Trends in wealth inequality: recent literature

- *data:* Saez and Zucman 2015, Kopczuk 2015, Bricker, Henriques, Krimmel, and Sabelhaus 2016.
- *models of Pareto tails:* Piketty and Zucman 2015, Benhabib, Bisin, and Luo 2015, Nirei and Aoki 2015.
- *models of transitions:* Kaymak and Poschke 2016, Gabaix, Lasry, Lions, and Moll 2016, Aoki and Nirei 2016.

Equilibrium: capital market clearing

need to find two equilibrium objects $(K_t, \underline{r}_t)$ for market clearing:

1. aggregate capital (as usual)

$$K_t = \int a_t d\Gamma(a_t)$$

2. aggregate capital income (redundant if $r_t^X(\cdot) = 0$)

$$(MPK(K_t) - \delta)K_t = \int \left(\underline{r}_t + r_t^X(a_t)\right) a_t d\Gamma(a_t)$$

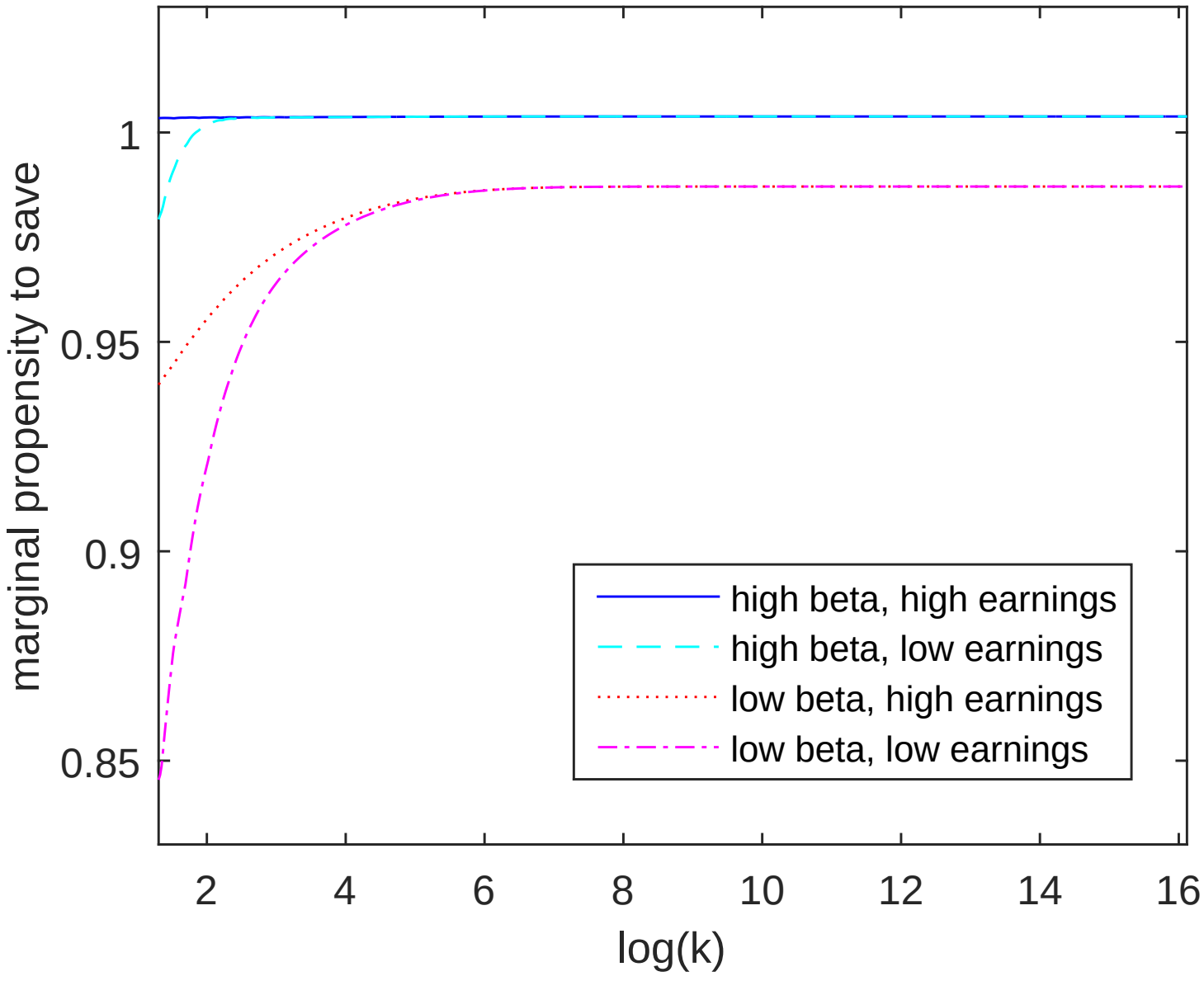
Multiplicative shocks and Pareto tails

- linear savings rules as wealth grows large (Bewley 1977; Carroll 2012; Benhabib et al. 2015): $\lim_{x\to\infty} s(x,\beta) = \bar{s}_\beta x$.
- asset accumulation for large x:

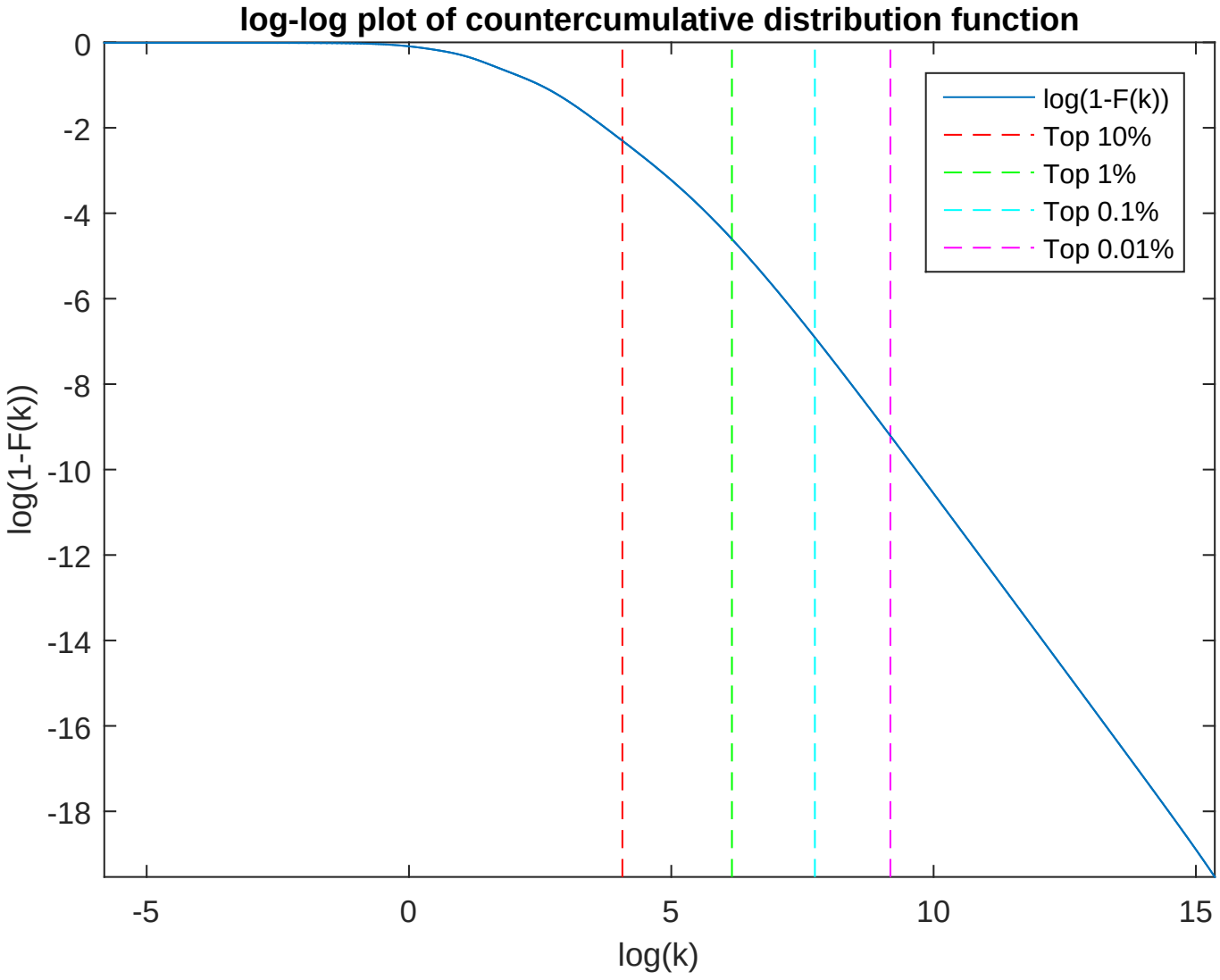
$$\begin{aligned} a_{t+1} &= s(x_t,\beta) \\ &= s(a_t + y_t - T(y_t),\beta) \\ &\approx \bar{s}_\beta a_t(1+(1-\tau_{\max})r) + \bar{s}_\beta(1-\tau_{\max})e_t \\ &\equiv \hat{s}a_t + z_t, \end{aligned}$$

  where e_t is earnings.
- β and/or r random $\to$ $\hat{s}$ is random.
- with reflecting barrier (borrowing constraint) and/or random earnings, the invariant distribution for wealth has a Pareto tail with coefficient ζ solving: $\mathbb{E}[\hat{s}^\zeta] = 1$.

Stochastic-β yields stochastic, linear savings decisions



Gives rise to a Pareto tail in the wealth distribution



Cumulative change in top wealth shares

		Top 10%	Top 1%	Top 0.1%	Top 0.01%
Data	1967	70.8	27.8	9.4	3.1
	2012	77.2	41.8	22.0	11.2
	Relative Δ	9.0%	50.4%	134.0%	261.3%
Model	1967	73.8	27.4	8.4	3.2
	2012	78.5	36.5	14.4	5.6
	Relative Δ	6.4%	33.2%	72.2%	75.4%
Fraction explained		70.8%	65.9%	53.8%	28.9%

Wealth shares in %.
Data (capitalization): Saez & Zucman 2016.

... when compared to SCF data

		Top 10%	Top 1%	Top 0.1%
Data	1989	67.1	30.1	10.8
	2013	75.3	35.8	13.5
	Relative Δ	12.2%	19.1%	25.4%
Model	1989	69.3	24.5	7.4
	2013	78.9	37.1	14.8
	Relative Δ	13.7%	51.5%	100.3%
Fraction Explained		112.5%	270.1%	394.5%

Wealth shares in %.

Data: SCF, as reported by Saez & Zucman 2016.

Other parts of the distribution

		Bottom 50%	$\frac{\text{personal wealth}}{Y}$	$\frac{\text{nat'l wealth}}{Y}$	$\frac{K}{Y}$
Data	1967	4.0%	3.6	4.1	
	2010	1.1%	4.1	4.6	
	Relative Δ	-73%	14%	14%	
Model	1967	3.0%			4.0
	2010	1.4%			4.4
	Relative Δ	-53%			10%
Fraction explained		74%			

Bottom 50% Data: SCF, as reported by Kennickell 2011.
Personal/national wealth data: Piketty & Zucman 2014.

Excess return schedule details

Aggregate Excess Returns in 1967 steady state (over risk-free rate):

- public equity 0.067
- private equity 0.129
- housing 0.037 (incl. imputed rent)

	P0-P40	P40-P50	P50-P60	P60-P70	P70-P80	P80-P90	P90-P95	P95-P97.5	P97.5-P99	P99-P99.5	P99.5-P99.9	P99.9-P99.99	Top 0.01%
fixed portfolio weights													
cash	0.722	0.412	0.248	0.182	0.156	0.134	0.115	0.102	0.090	0.079	0.071	0.051	0.029
housing	0.162	0.394	0.580	0.662	0.678	0.674	0.658	0.626	0.572	0.482	0.363	0.253	0.155
public equity	0.113	0.189	0.165	0.147	0.153	0.170	0.189	0.207	0.219	0.232	0.230	0.185	0.179
private equity	0.002	0.005	0.007	0.009	0.013	0.021	0.038	0.065	0.118	0.207	0.336	0.511	0.637
difference from aggregate return on asset class													
cash	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
housing	0.000	0.000	0.002	0.004	0.005	0.007	0.009	0.010	0.010	0.011	0.010	0.010	0.011
public equity	0.000	0.000	0.001	0.002	0.003	0.005	0.008	0.012	0.014	0.015	0.016	0.016	0.016
private equity	0.000	0.000	-0.019	-0.030	-0.054	-0.055	-0.049	-0.066	-0.064	-0.063	-0.063	-0.059	-0.060
standard deviation of return on asset class													
cash	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
housing	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.140
public equity	0.035	0.035	0.031	0.031	0.031	0.031	0.032	0.033	0.035	0.038	0.042	0.046	0.053
private equity	0.664	0.664	0.621	0.595	0.544	0.525	0.518	0.480	0.474	0.470	0.474	0.492	0.443
private equity (re-scaled)	0.345	0.345	0.323	0.309	0.283	0.273	0.269	0.249	0.246	0.245	0.246	0.256	0.230
excess return schedule in 1967													
mean excess return	0.000	0.011	0.017	0.020	0.022	0.026	0.031	0.035	0.041	0.050	0.062	0.079	0.091
standard deviation	0.023	0.056	0.081	0.093	0.095	0.095	0.094	0.093	0.098	0.119	0.167	0.254	0.283
st. dev. (priv.equ. re-scaled)	0.023	0.056	0.081	0.093	0.095	0.095	0.093	0.089	0.086	0.085	0.098	0.136	0.149

Housing details

- financial return on housing as sum of capital gains term and rental income
- we set capital gains term to zero in steady states (in long run 0-0.5% real price growth)
- over transition, use growth in aggregate house price index (Case-Shiller)
- rental income set to 5.33% (average for U.S. from Jorda, Knoll, Kuvshinov, Schularick, Tayler "Rate of Return on Everything")

Public and private equity

Public Equity

- U.S. stock market return

Private Equity

- Kartashova (AER, 2014) documents private equity premium over stock market
- aggregate time series for U.S. starting in 1960

Capital in the 21st century?

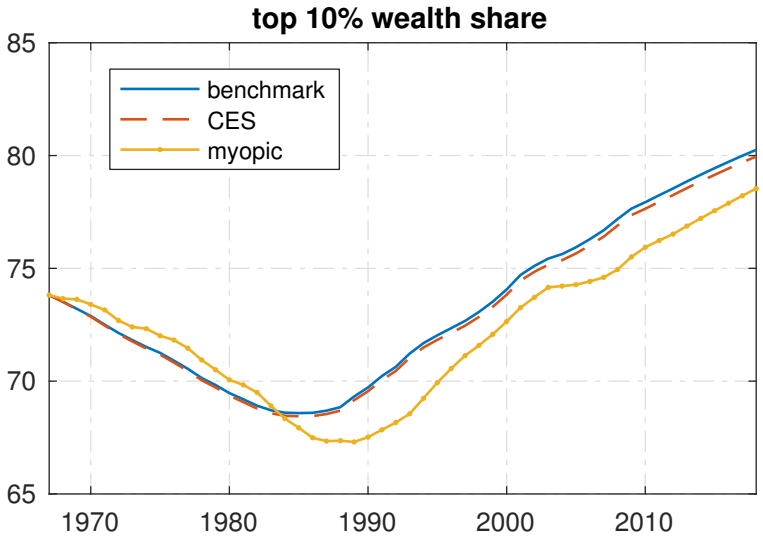
	Top 10%	Top 1%	Top 0.1%	Top 0.01%	Bottom 50%
1967	73.8	27.4	8.4	3.2	3.0
2017	80.0	39.2	16.2	6.5	1.2
2100	89.1	61.6	35.2	17.0	0.3

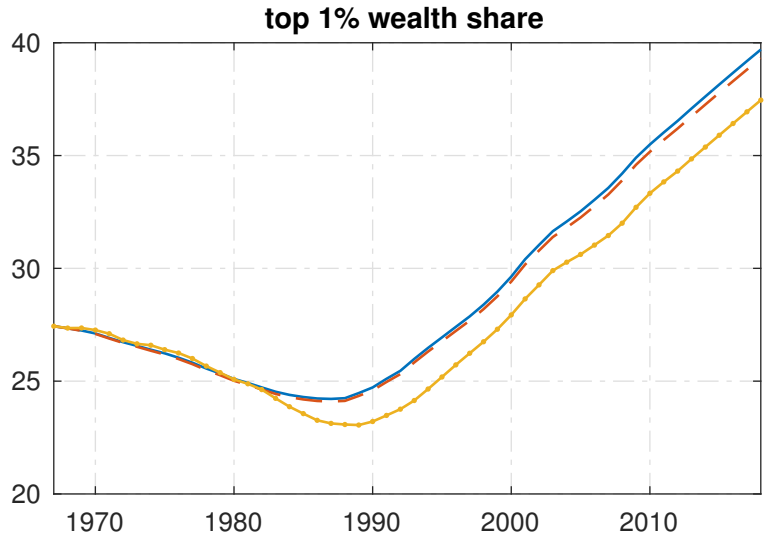
Model predictions for 21st century. Wealth shares in %.

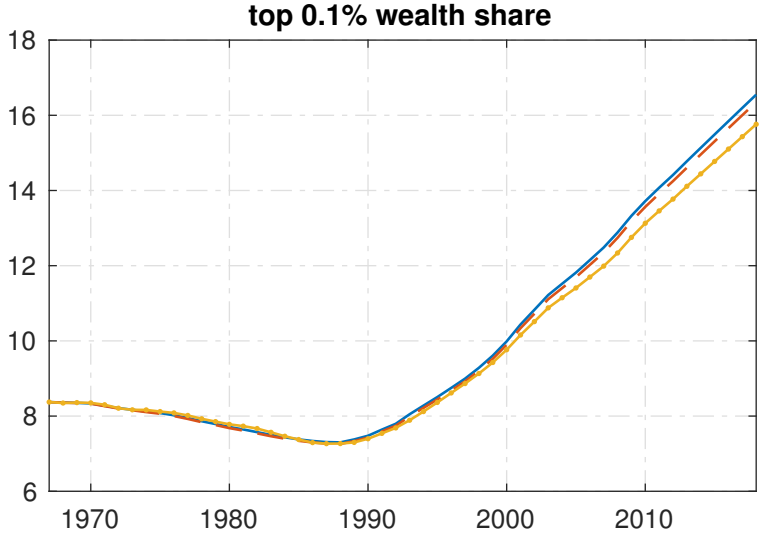
- long-run effects of decrease in tax progressivity

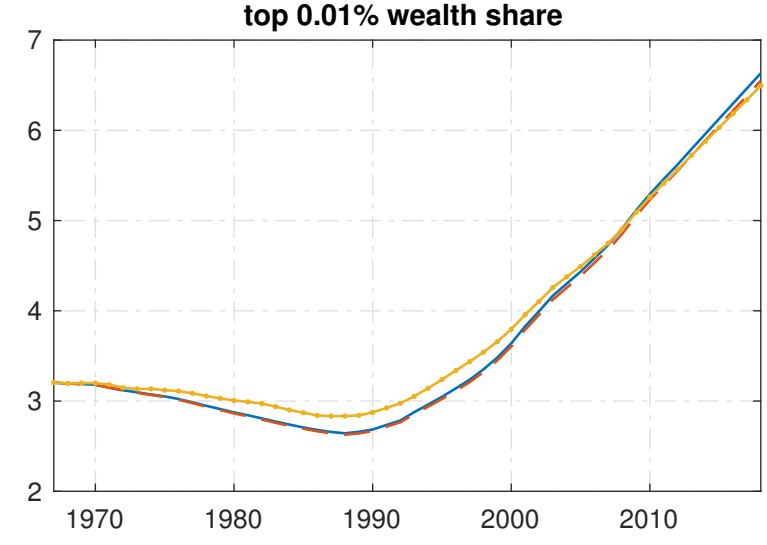
Perfect foresight vs. myopic transition; CES

return



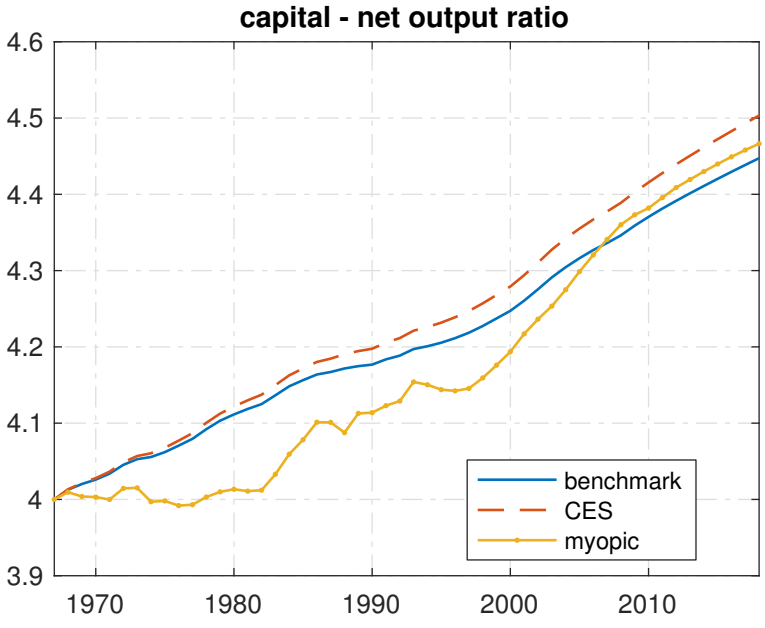


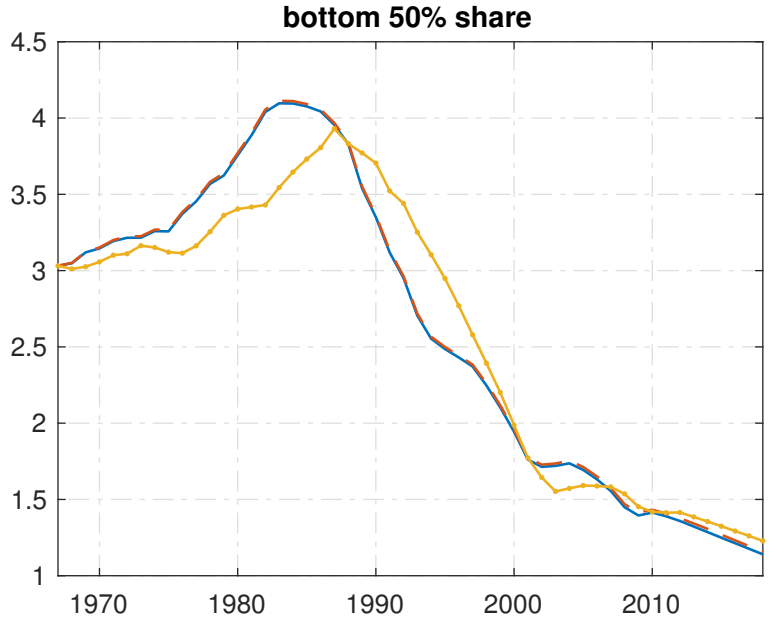




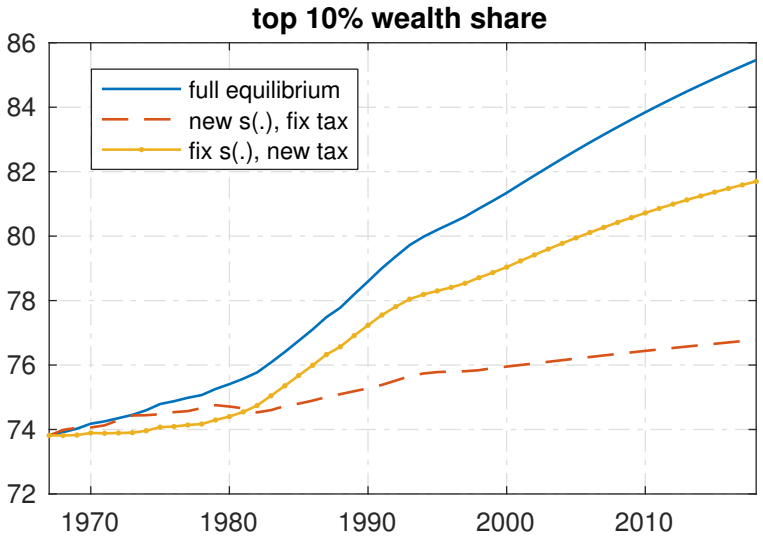
Perfect foresight vs. myopic transition; CES

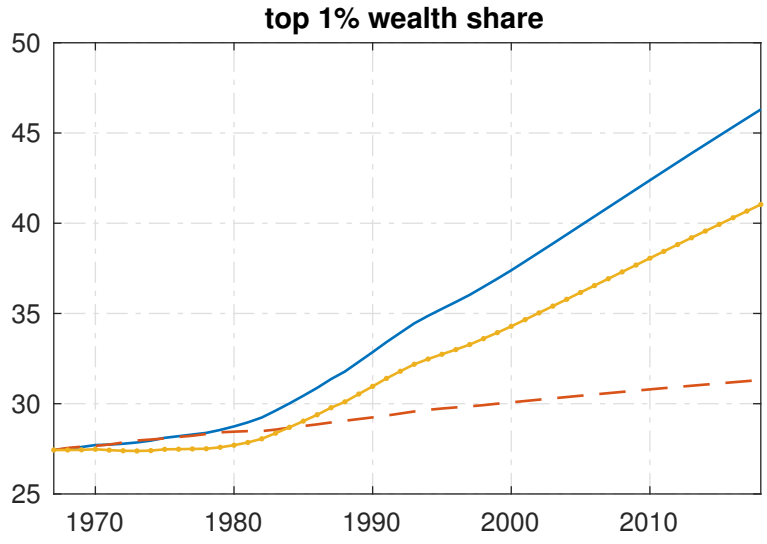
return

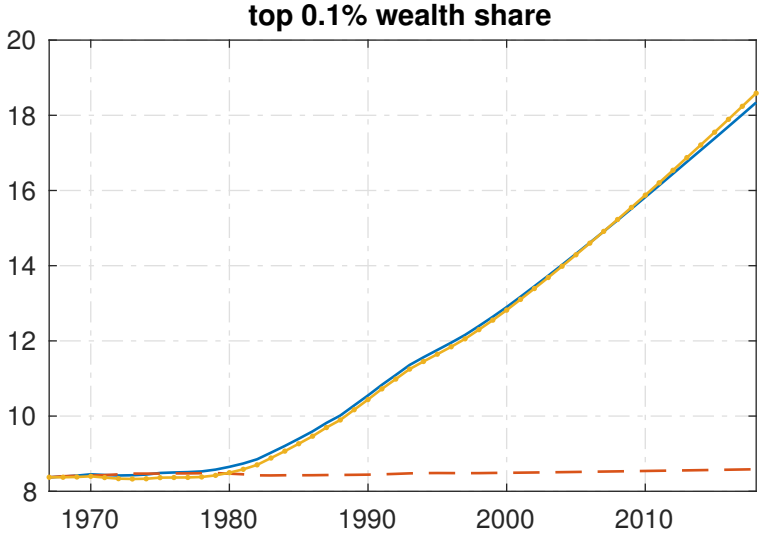


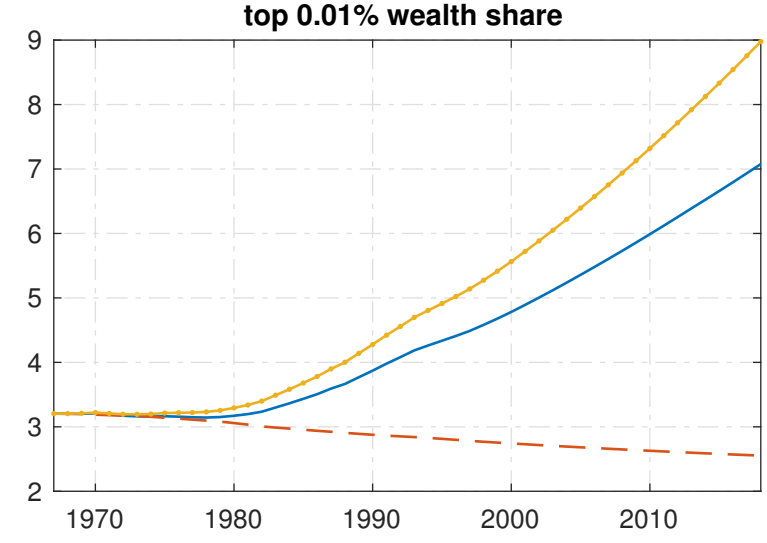


Tax changes: changes in savings behavior vs. resources



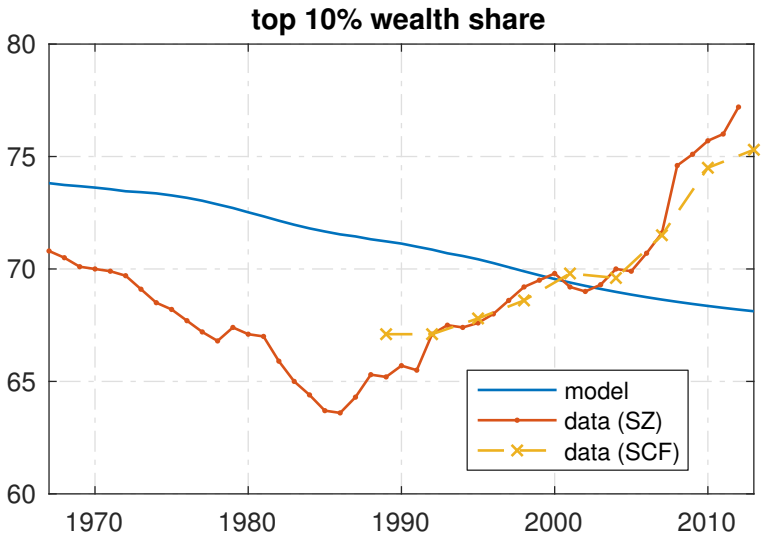


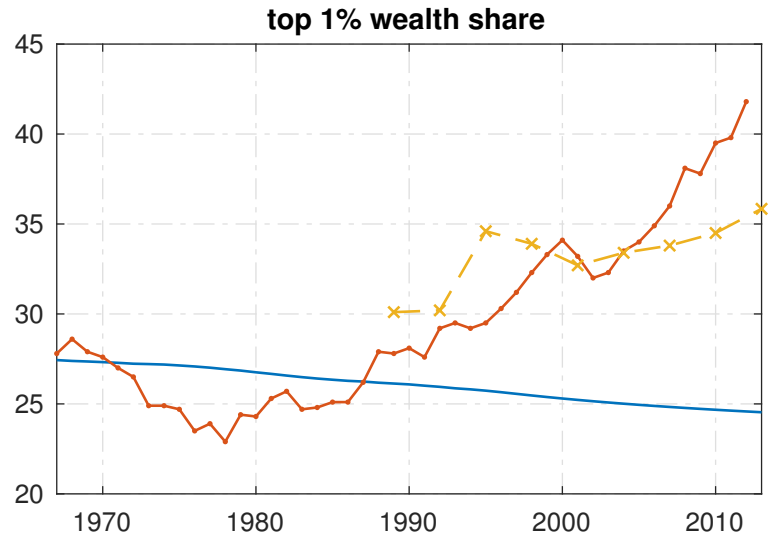


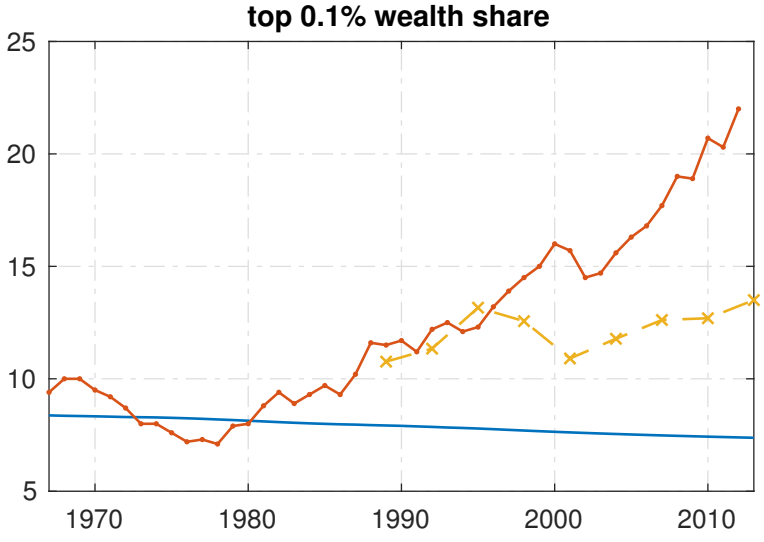


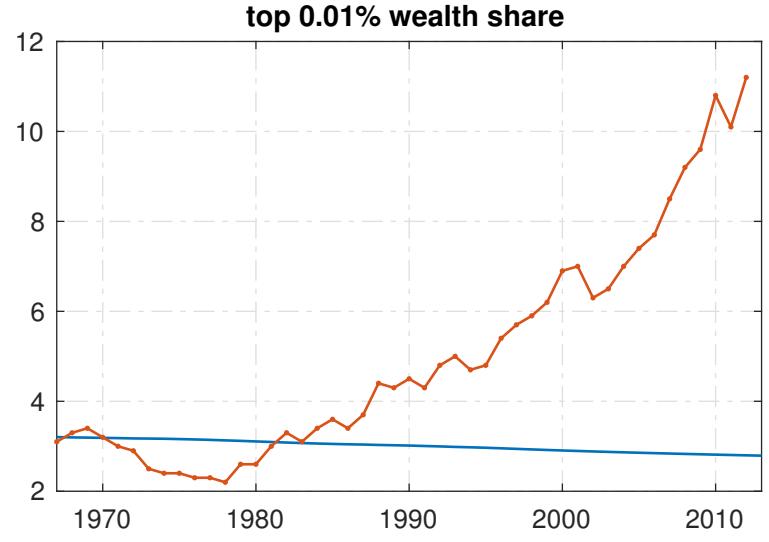
Only changes in earnings risk I

return



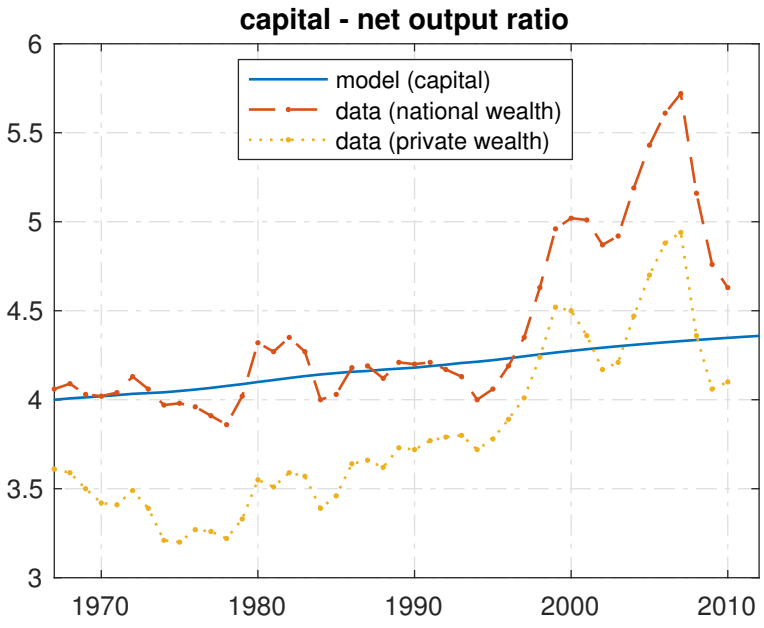


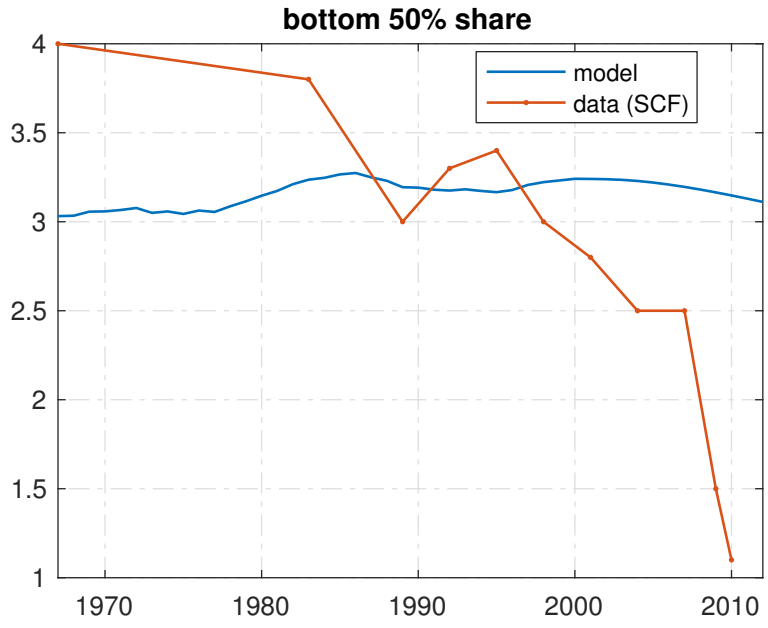




Only changes in earnings risk II

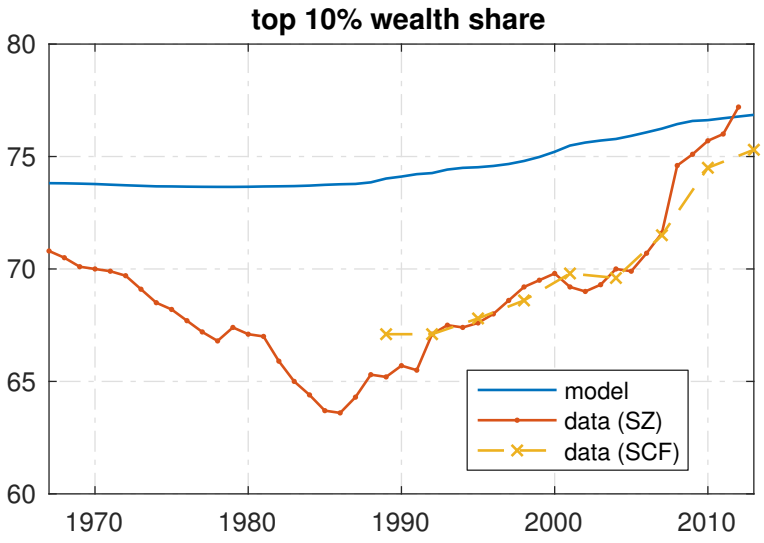
return

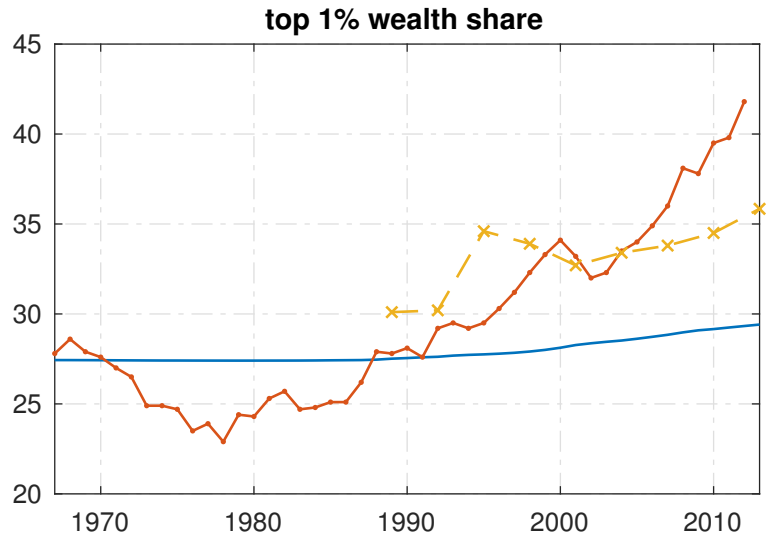


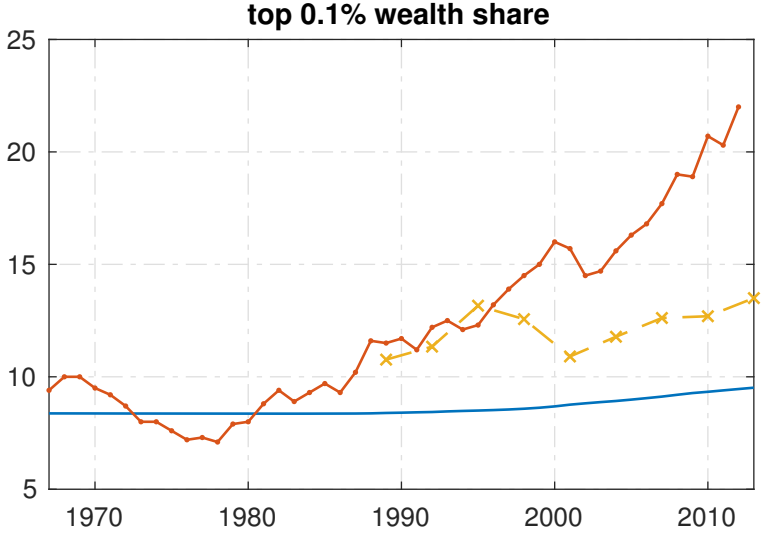


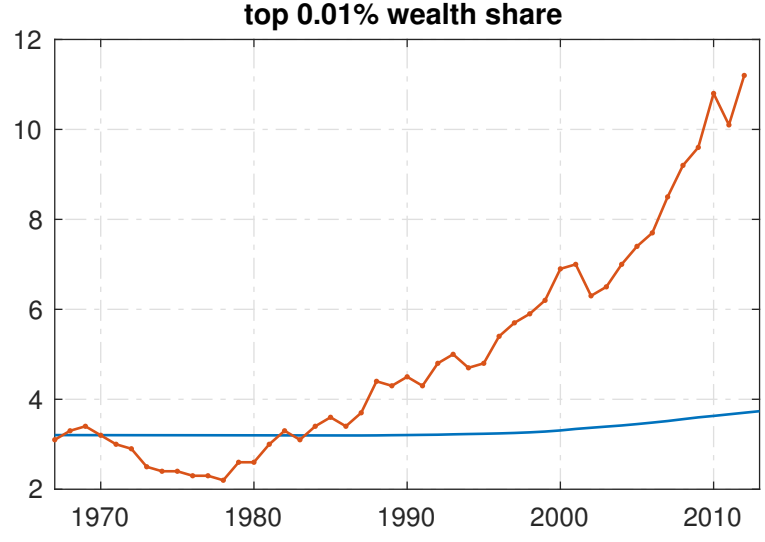
Only changes in top earnings shares I

return



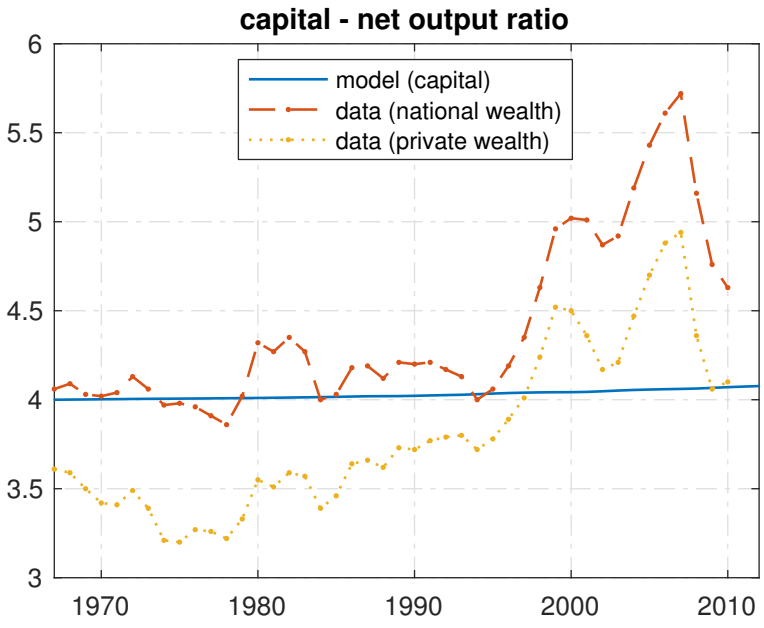


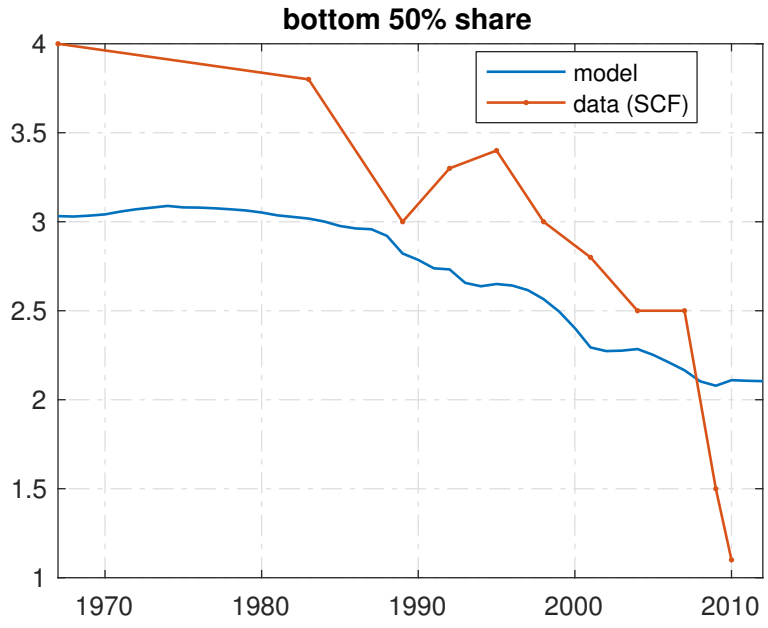




Only changes in top earnings shares II

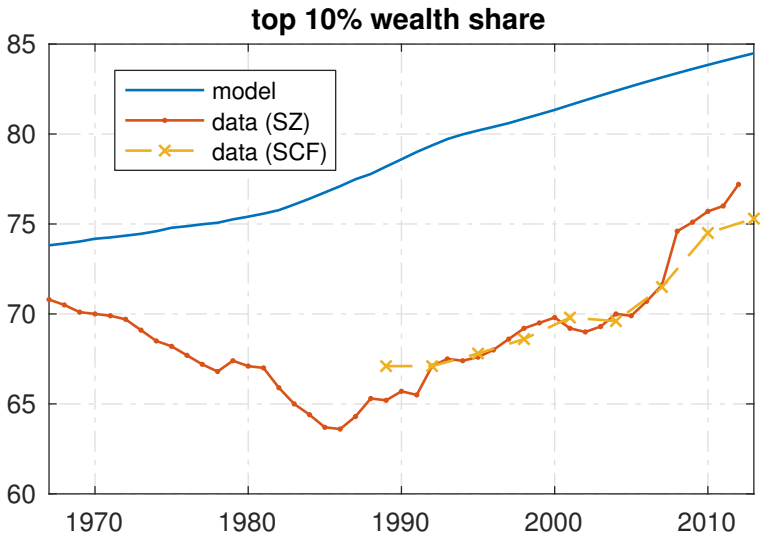
return

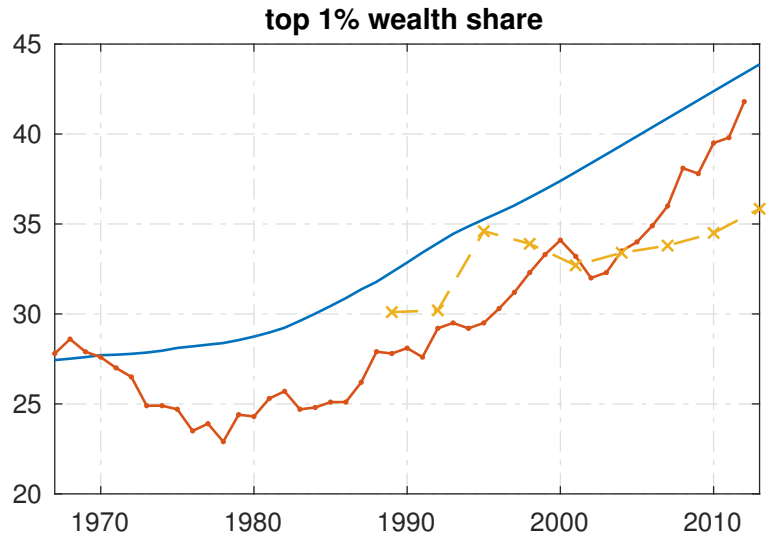


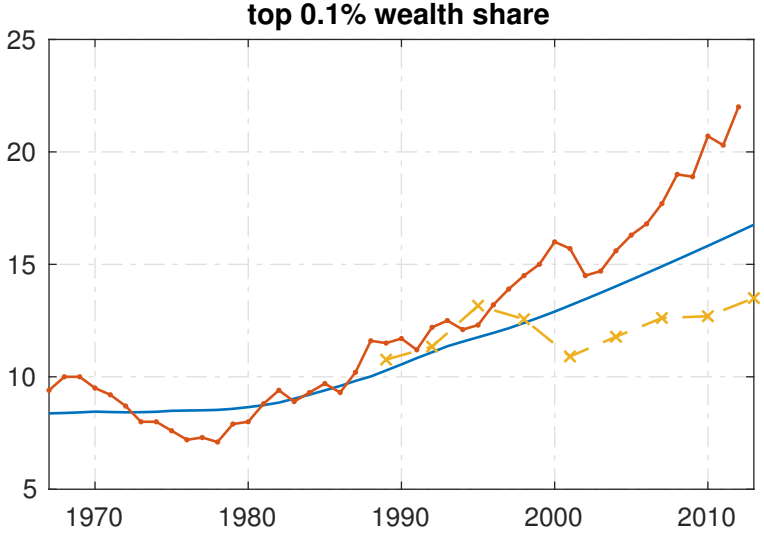


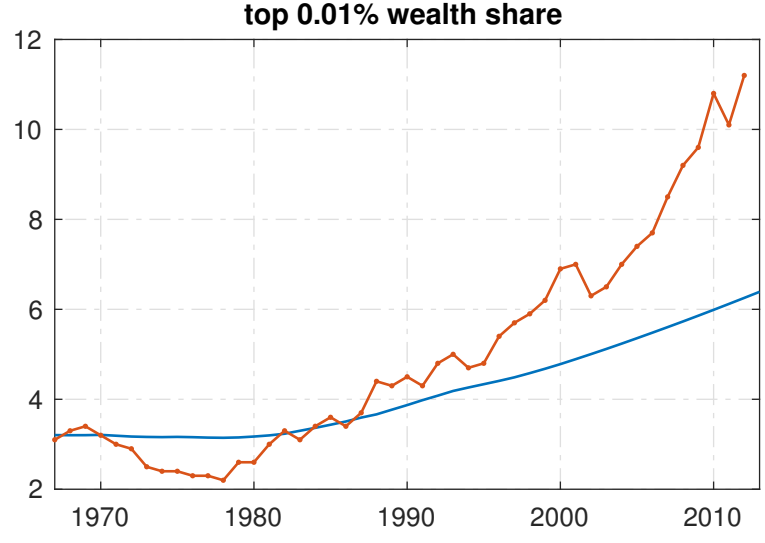
Only changes in taxes I

return









Only changes in taxes II

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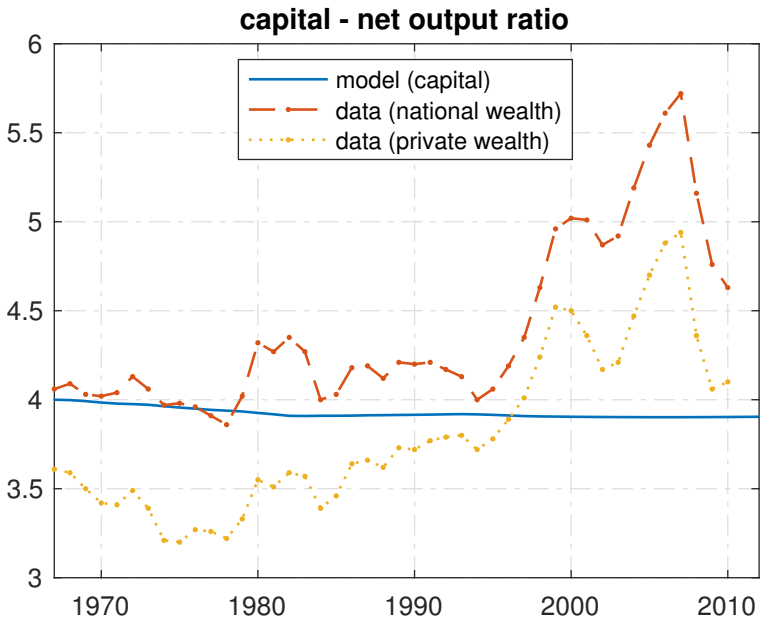

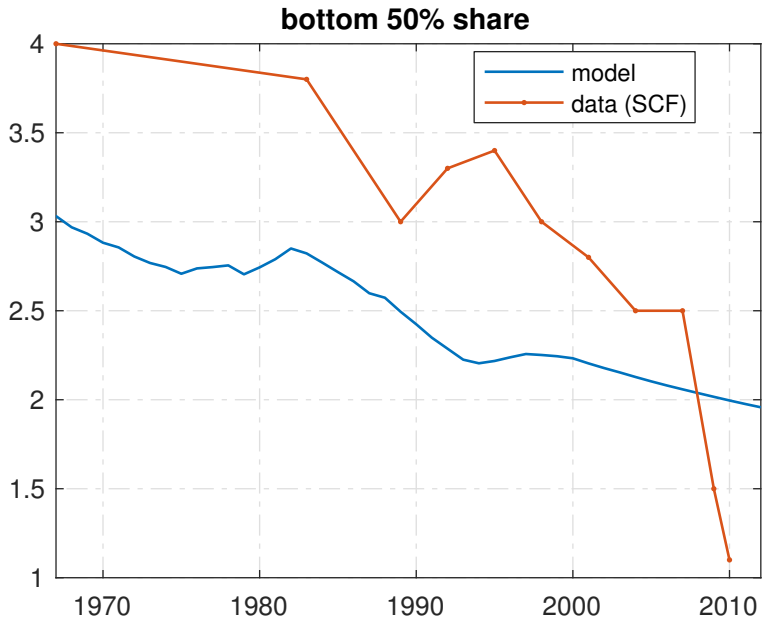

Only changes in return premia I

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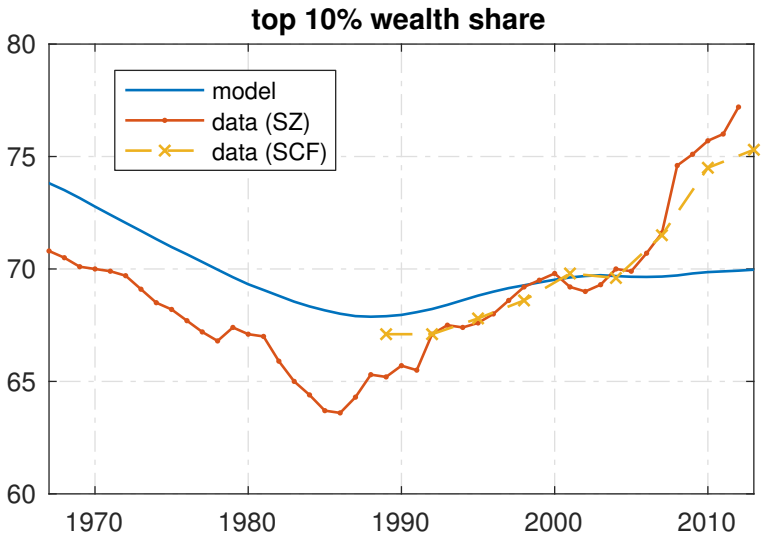
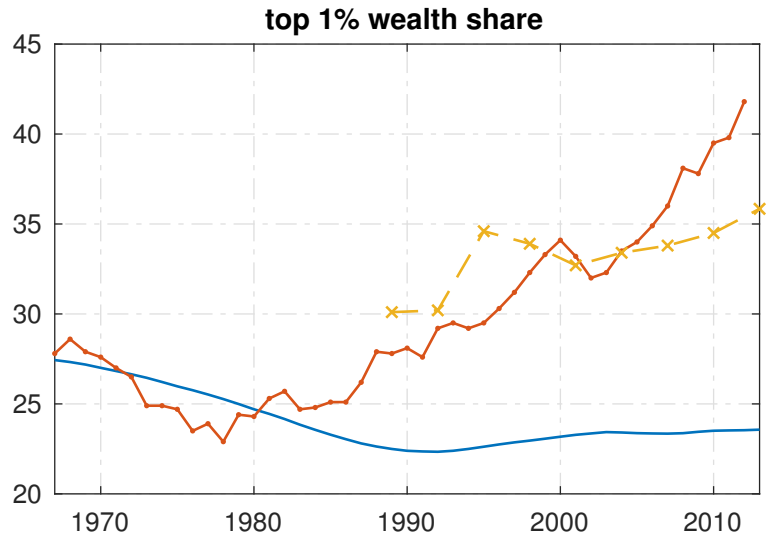
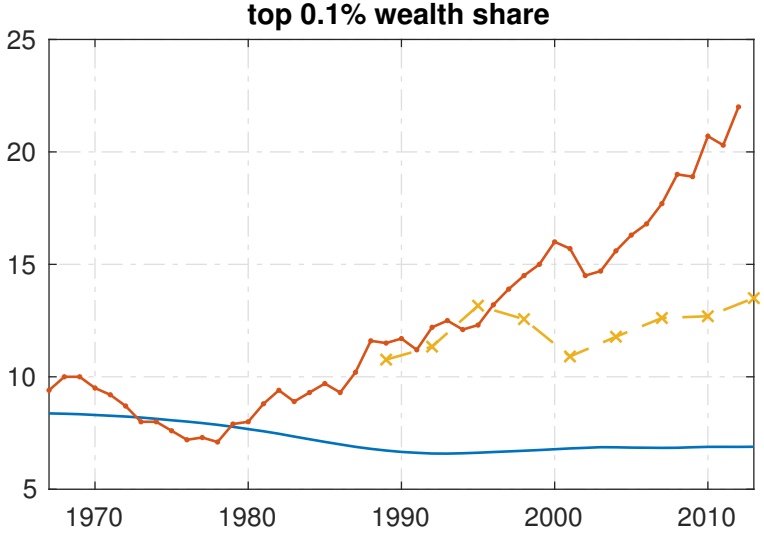
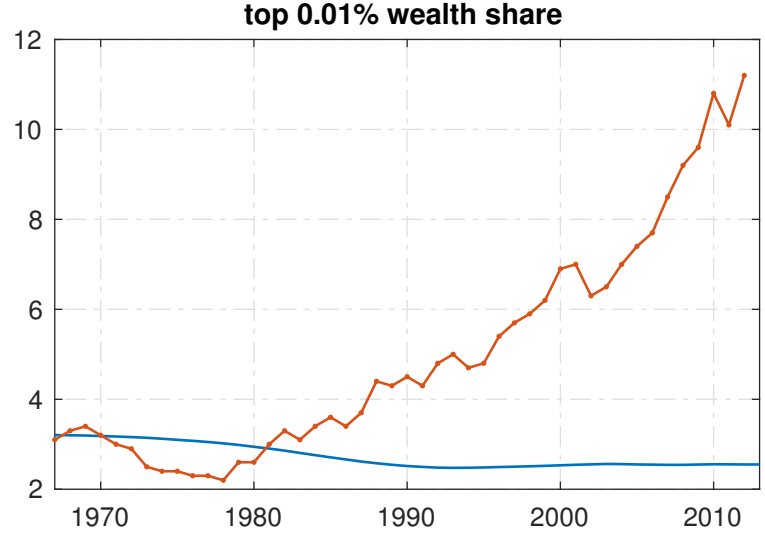


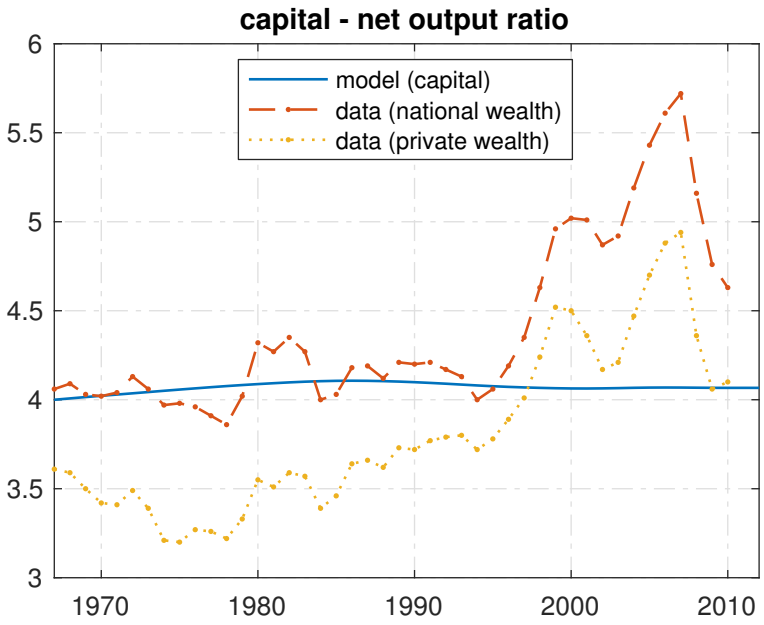


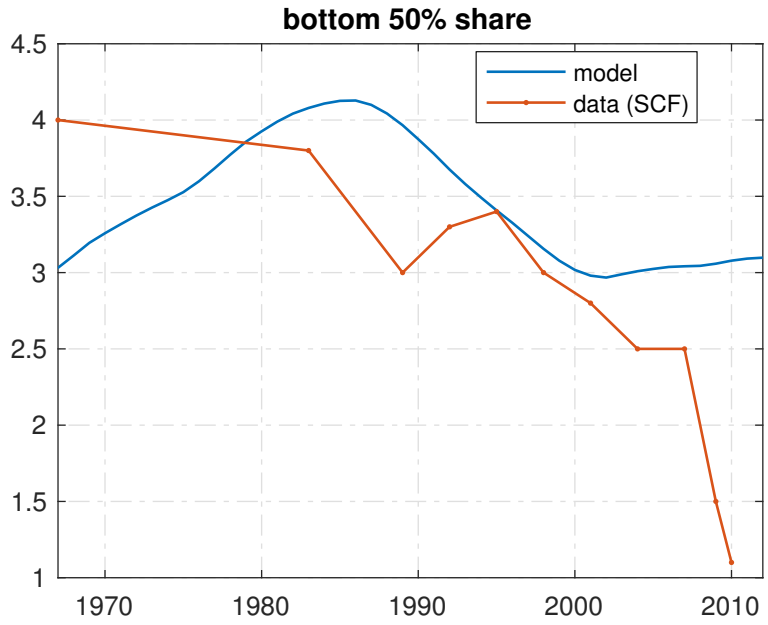




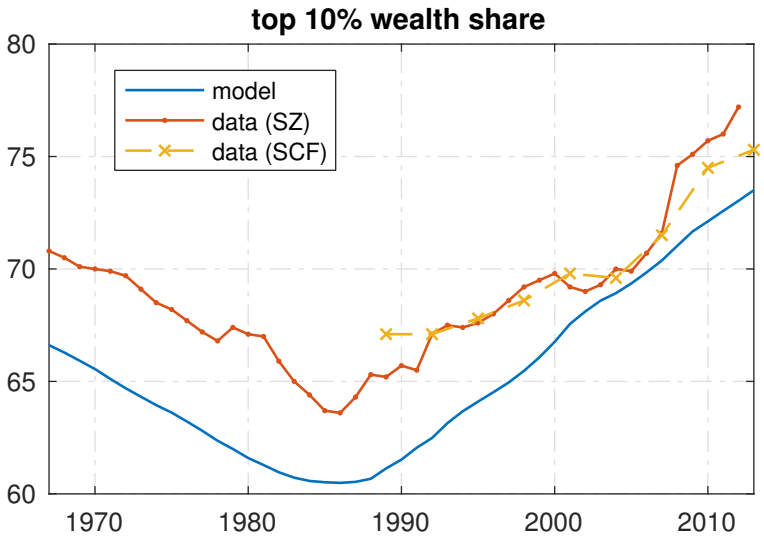
Only changes in return premia II

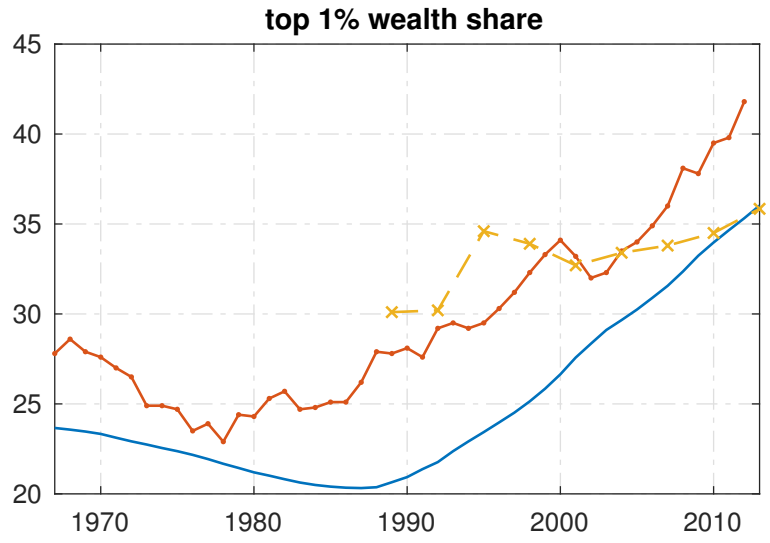
return

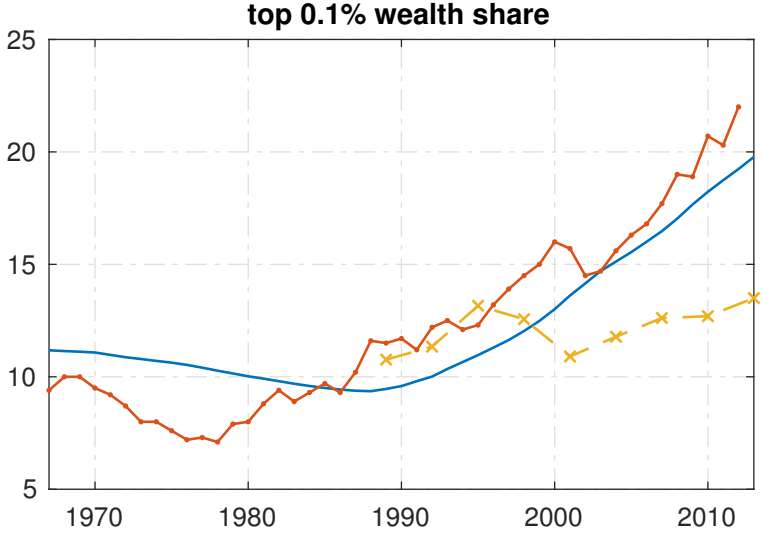


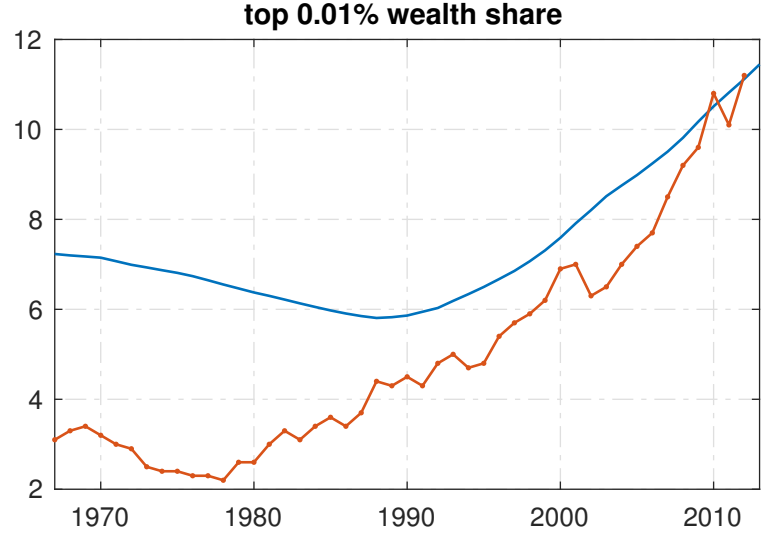


Dynamics in single-β model I

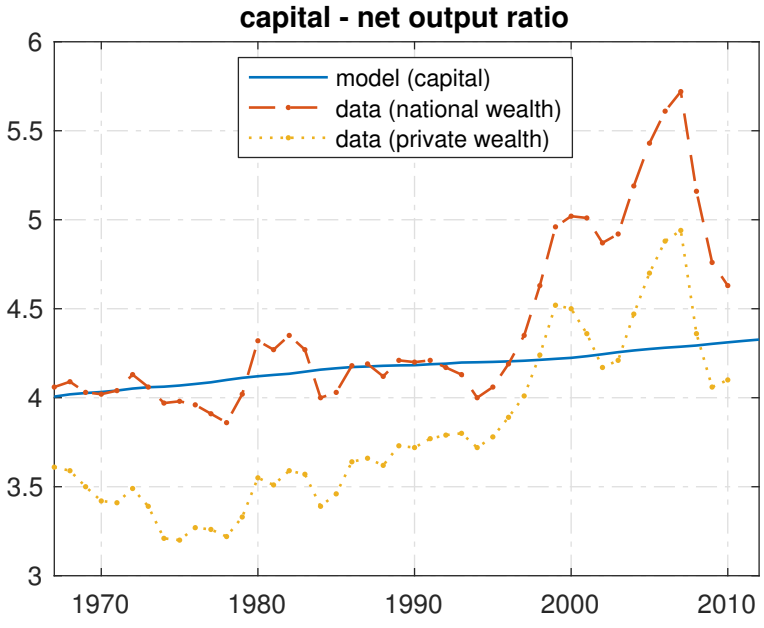


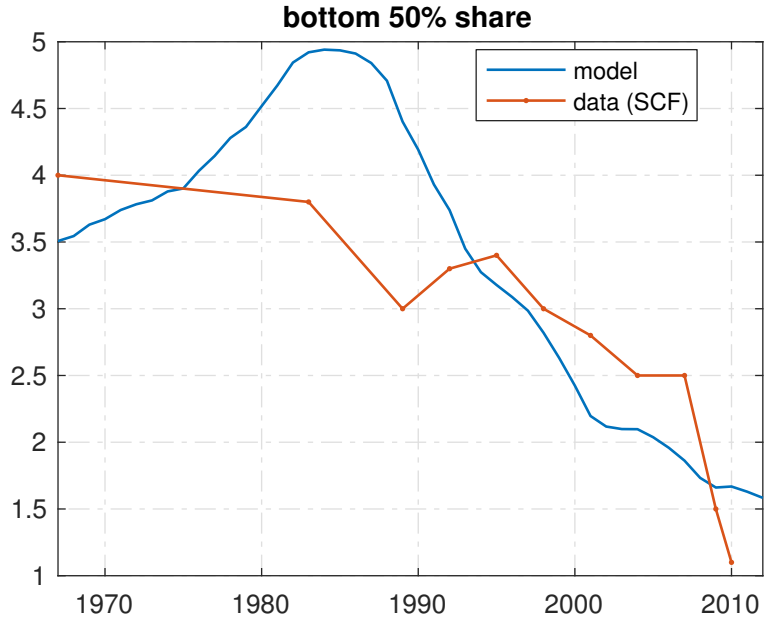




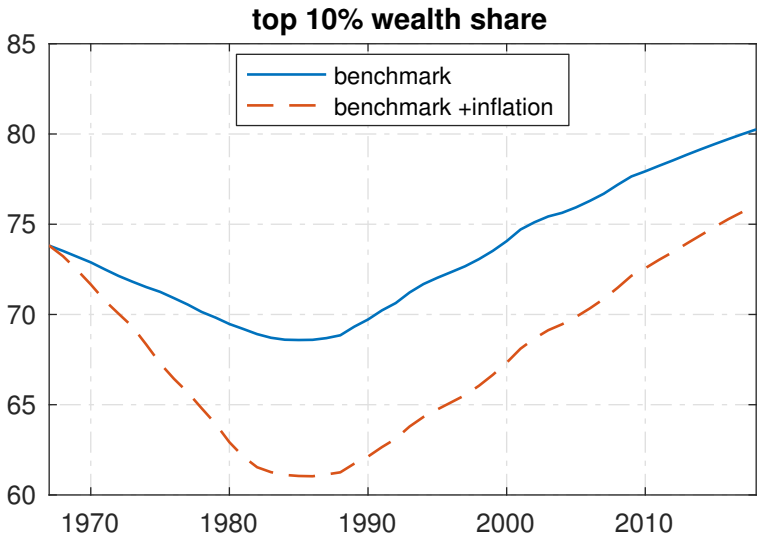


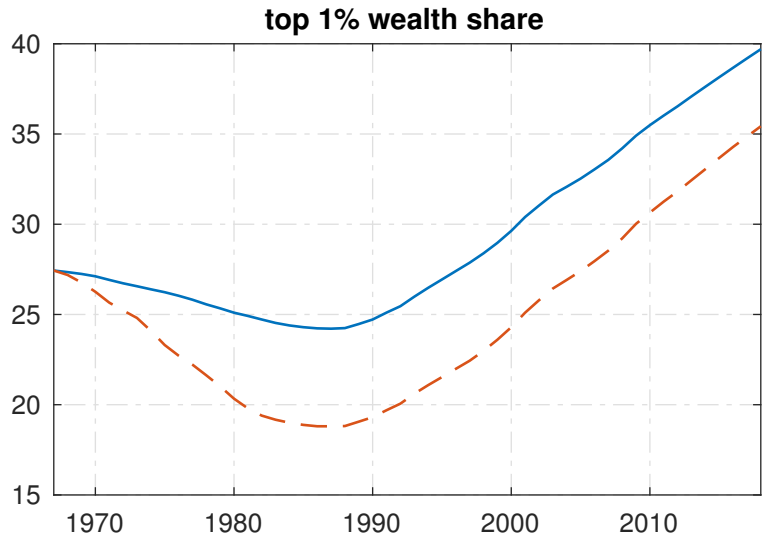
Dynamics in single-β model II

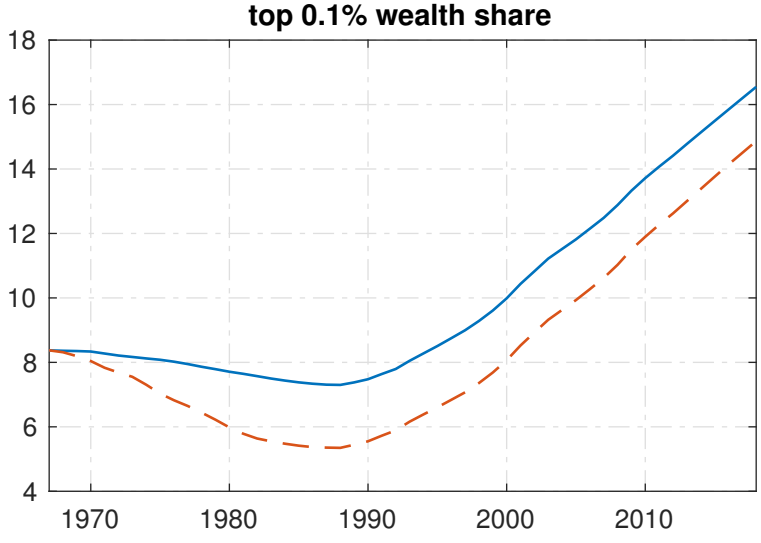


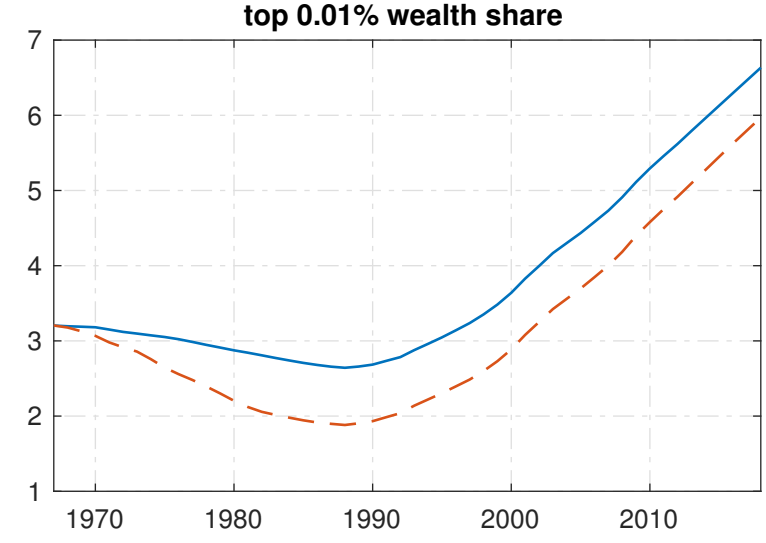


Inflation I


top 10% wealth share
benchmark
benchmark +inflation
85
80
75
70
65
60
1970
1980
1990
2000
2010


top 1% wealth share
40
35
30
25
20
15
1970
1980
1990
2000
2010


top 0.1% wealth share
18
16
14
12
10
8
6
4
1970
1980
1990
2000
2010


top 0.01% wealth share
7
6
5
4
3
2
1
1970
1980
1990
2000
2010

Inflation II