On the Mechanics of Top Wealth Inequality

With An Application to Wealth Taxation

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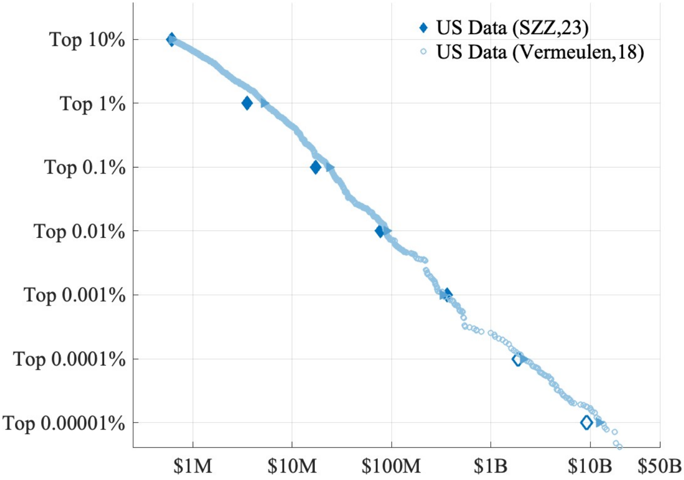
NBER SI - Inequality and Macroeconomics

July 15th, 2025

Wealth is Extremely Concentrated at the Top

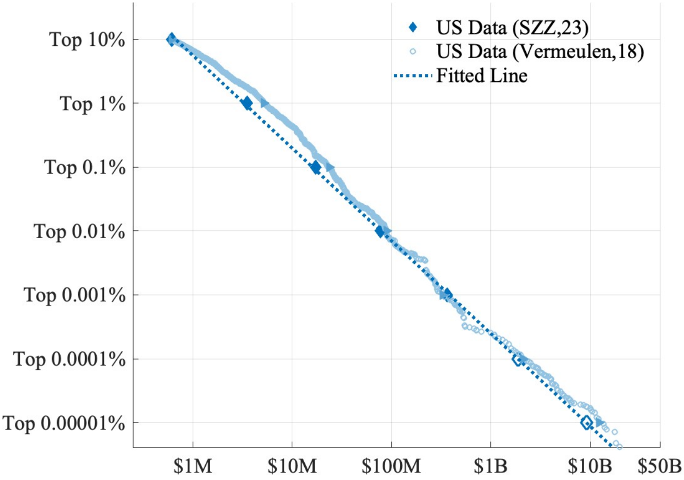
Wealth is Extremely Concentrated at the Top: US

Right Tail: Log Counter-CDF $(\Pr(w > x))$ vs Log Wealth



Wealth is Extremely Concentrated at the Top: US

Shape: A straight line implies a Pareto distribution: $P(w > x) \sim x^{-\alpha}$



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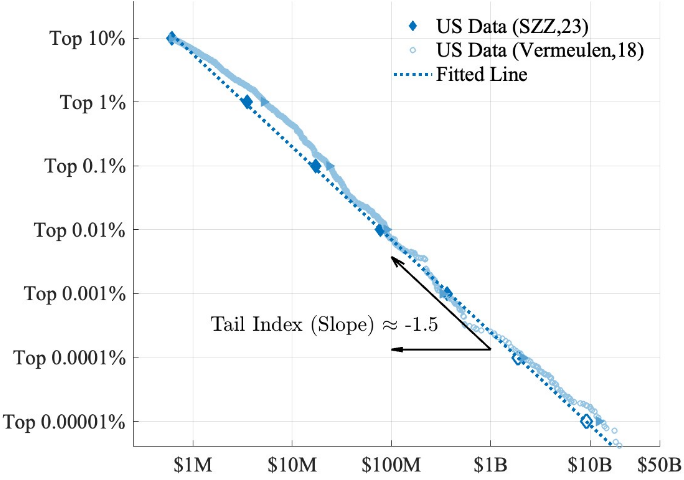
Thickness: Slope gives the tail index α



True in Most of the Developed Economies

	Pareto Tail Index for Wealth									
	Germany	Austria	Portugal	**US**	Italy	France	Spain	UK	Belgium	**Finland**
Tail Index	**1.39**	1.46	1.47	**~1.50**	1.58	1.62	1.69	1.74	1.87	**1.88**

Source: Vermuelen (RIW, 2018). Tail indices are estimated from country level surveys merged with Forbes' billionaires list.

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- **Thickness:** All countries with $\alpha < 2$. Very thick tail! (technically, Var (wealth) does not exist)
  - Matters in practice: Models with thick Pareto tail are harder to solve accurately.

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- **Why care about Pareto?** No super rich without Pareto...Even if top 1% share matched
  - Many policy debates are (were!) about taxing 100-millionaires, billionaires, etc.

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- **Today:** Models that feature 1 through 5. How (well) do they generate wealth inequality?
- **Not Today:** Stochastic-beta, Heterogeneous risk aversion, Non-homothetic pref., etc.

(Largely because we already have a good guess about their impact.)

Example

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   - Persistent return heterogeneity across households.
     (Fagereng, Guiso, Malacrino, Pistaferri, ECMA, 2020; Smith, Zidar, Zwick, QJE, 2023; etc)

   Two versions: *(i)* Entrepreneurship-based full-fledged macro model

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3. **Demographic structure** and wealth distribution: **Who holds the wealth?**

General Framework

I. Preferences and Demographics: 2 Versions

Version 1: CRRA Utility + Warm-Glow Bequests + **Perpetual-Youth** (cons. surv. ϕ)

$$U = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \Big(\underbrace{\phi}_{\text{Survival prob.}} \times u(c_t) + (1-\phi) \times \underbrace{v(b)}_{\text{Warm-glow bequest}} \Big)$$

$$u(c) = \frac{c^{1-\sigma}}{1-\sigma} \qquad v(b) = \chi \frac{(b+b_0)^{1-\sigma}}{1-\sigma}$$

$\longrightarrow$ Used for Framework 1: **Awesome-State Model**

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Version 2: CRRA Utility + Warm-Glow Bequests + **Finite Horizon T** + **Stoch. Death** (ϕ_t from data)

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- Perpetual-youth will be critical ...as we will see

II. Household Consumption-Savings Problem

- Consumption-savings problem at the core of all 3 frameworks (ignoring bequests)

$$
\begin{aligned}
\mathcal{V}_t\left(a_t^i\,;\,\mathbf{Y_t^i}\right) \;=\; \max_{c_t^i,\,a_{t+1}^i}\; \left\{\; U\left(c_t^i\right) \;+\; \beta\phi_{t+1}\mathbb{E}\left[\mathcal{V}_{t+1}\left(a_{t+1}^i\,;\,\mathbf{Y_{t+1}^i}\right) \;\middle|\; \mathbf{Y_t^i}\right]\;\right\} \\
\text{s.t.}\quad c_t^i \;+\; a_{t+1}^i \;=\; Ra_t^i \;+\; \mathbf{Y_t^i}, \\
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- **In Aiyagari-style models** (Frameworks 1–2), risk comes from stochastic $\mathbf{Y_t^i}$ (labor income)
  - No wealth Pareto (without thick tail inc shocks; Stachurski, Toda, 2019; Sargent, Wang, Yang, 2021)

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- **In Power-Law models** (Framework 3), risk comes from stochastic $\mathbf{R_t}$
  - Generate Pareto tail in wealth (thicker than income!)
  - But: How thick? How long does it take to emerge? $\longrightarrow$ Empirical questions

III. Return Process: Two Options

1 **Fully-fledged model:** Entrepreneurial returns (Guvenen, Kambourov, Kuruscu, Ocampo, Chen, QJE, 2023)

- Individuals differ in *entrepreneurial ability* z_t^i (permanent + transitory components)
- Returns from entrepreneurial profits

$$\pi_t^i = \max_{k_t^i \leq \vartheta\left(\bar{z}^i\right) \times a_t^i} \mathcal{P} \times \left(z_t^i k_t^i\right)^{\mu} - (R + \delta)\, k_t^i$$

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2. **Proposed benchmark: Simple Markovian returns** consistent with wealth inequality facts

$$R_t^i = R \times \exp\left(z_t^i\right) \qquad \text{where } z_t^i \text{ follows a Markov Chain}$$

   - Later allow for permanent types

Calibration of Models

		Frameworks	
	Awesome-State	PEER Model	Return Heterogeneity
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3.	Wealth-to-Income Ratio		4	
4.	Average HH. Earnings		\$60,462	

- Earnings correspond to total wages and salaries per household in 2016 (BLS; Census)
- Wealth level determined by average returns to wealth

details

Road Map

1. **Income Dynamics:**
   1. Income Processes
   2. Models vs Data
2. Wealth Inequality: Models vs Data
3. Demographics and Wealth: Models vs Data

Income Processes: 1. Awesome-State Model

	Stationary Distribution of Income, Y			
	s_1	s_2	s_3	s_4
Y	**1.00**	3.15	9.78	1,061
π	**61.1%**	22.4%	16.5%	0.0389%

Source: *Castañeda, Díaz–Giménez, Ríos–Rull (JPE, 2003)*

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- Key: Very transitory $\longrightarrow$ Fall back to median in ~5-10 years.

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Today: I will focus on Castañeda, Díaz–Giménez, Ríos–Rull (2003) version

We have also studied Kaymak and Poschke (2016); Grinwald, Leombroni, Lustig, Van Nieuwerburgh (2021); Kindermann and Krueger (2022); Boar and Midrigan (2022); etc.

Income Process: 2. PEER Model

Very rich income process with **21 parameters** *(Guvenen, Karahan, Ozkan, Song, ECMA, 2021)* ▸ details

Normal mixture persistent + transitory shocks; Non-employment shocks with scarring effects;

Shocks are age-income dependent; More!

- Matches 2000+ moments of **nonlinear and non-Gaussian** income dynamics

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Also consider alternative model with higher income inequality at the top *(more on this later!)*

Income Process: 3. Return Heterogeneity Model

- **Deliberately very standard:** Canonical persistent-plus-transitory income process:

$$\log y_t^i = \alpha^i + g(t) + \eta_t^i ;$$

$$\eta_t^i = \rho \eta_{t-1}^i + \varepsilon_t^i .$$

- All random objects are Gaussian (κ^i, ν_t^i)

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   - How dispersed are income changes?
   - Higher order moments: Skewness and Kurtosis matter for savings

Other features skipped for today:

Heterogeneous income growth over the life cycle; Income persistence of top earners; Distribution of income changes over longer horizons; Asymmetric Impulse response functions.

I. Income Inequality

Ratio of Top Percentile Threshold to Median Earnings

	Percentile Threshold		
	99%	99.9%	99.99%
US Data			
Awesome-State			
PEER Model			
Gaussian-AR			

I. Income Inequality

Ratio of Top Percentile Threshold to Median Earnings

	Percentile Threshold		
	99%	99.9%	99.99%
US Data	**8.5**		
Awesome-State	9.8		
PEER Model	14.8		
Gaussian-AR	6.6		

I. Income Inequality

Ratio of Top Percentile Threshold to Median Earnings

	Percentile Threshold		
	99%	99.9%	99.99%
US Data	8.5	**30.4**	
Awesome-State	9.8	9.8	
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US Data	8.5	30.4	**135.8**
Awesome-State	9.8	9.8	1061.0
PEER Model	14.8	33.6	65.0
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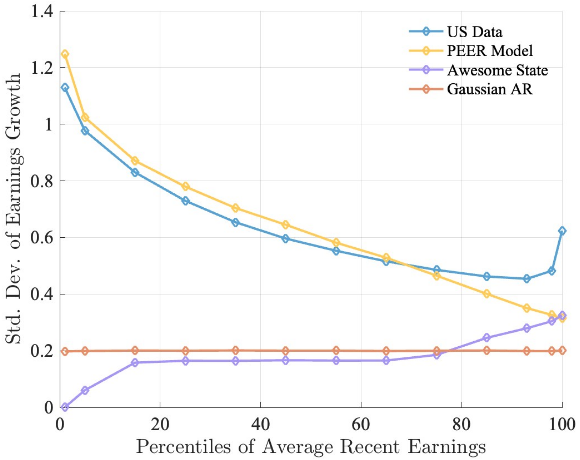
- Alternative PEER Model modified for higher income inequality $\longrightarrow \frac{y^{99.9}}{y^{50}} = 72\,;\ \frac{y^{99.99}}{y^{50}} = 334$
  - Thick *income* Pareto tail but *wealth* results qualitatively unchanged

Income Pareto

II. Income Risk: Standard Deviation of Income Growth

▸ Densities



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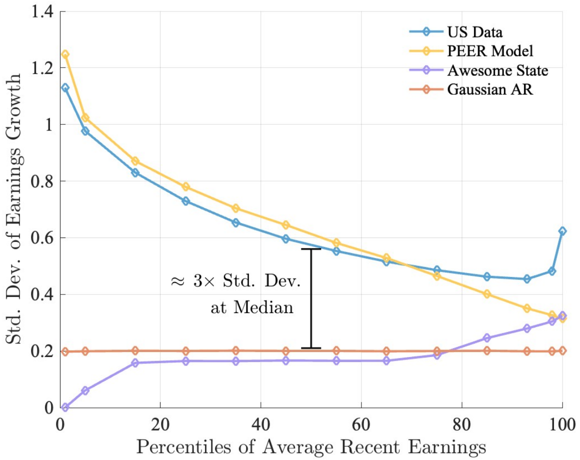

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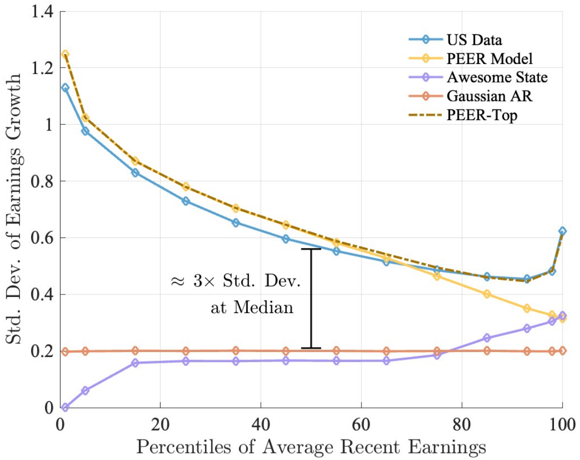
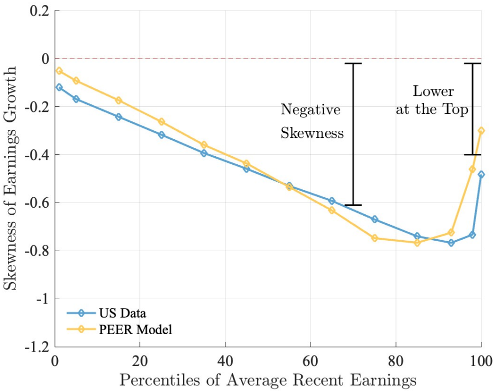


III. Income Risk: Skewness of Income Growth

More



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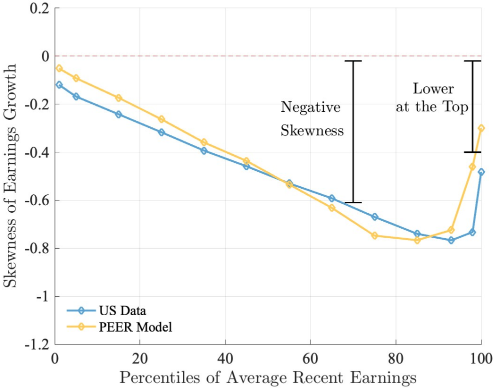

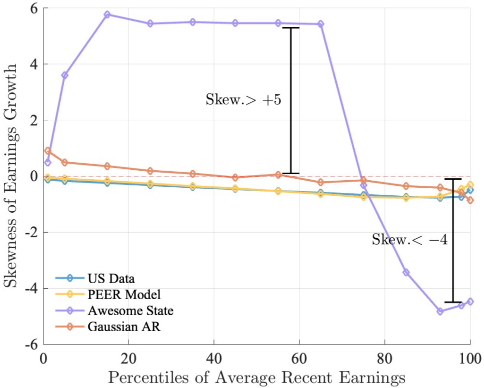

IV. Income Risk: Kurtosis of Income Growth

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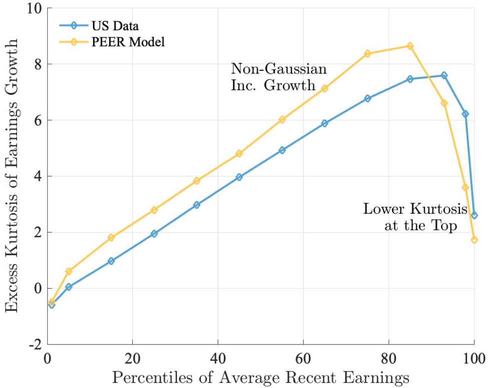

IV. Income Risk: Kurtosis of Income Growth

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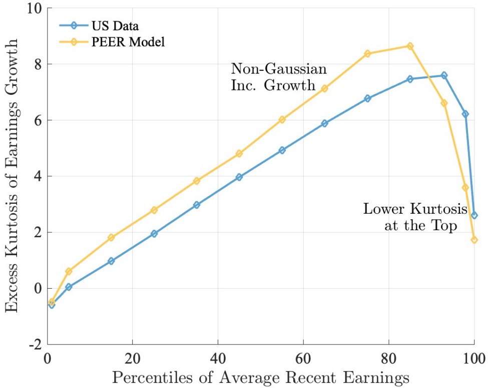

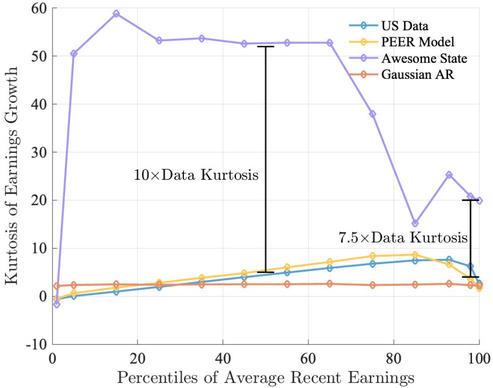

Road Map

1. Income Dynamics: Models vs Data
   1. Income Processes
   2. Models vs Data
2. **Wealth Inequality:**
   1. Return Heterogeneity
   2. Models vs Data
3. Demographics and Wealth: Models vs Data

Return Heterogeneity

	Cross-Section			Life-Time				
	Average	p90-p10	Std. Dev.	p90-p10	Std. Dev.	p90	p99	p99.9
PEER Model & Awesome State	3.0	–	–	–	–	–	–	–
Markovian Returns	12.2							
Entrepreneurial Returns	8.3							
Norway	3.8 (Private equity: 10)							

Notes: All statistics are wealth-weighted. Norwegian statistics from Fagereng, Guiso, Malacrino, Pistaferri (ECMA, 2020).

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PEER Model & Awesome State	3.0	–	–	–	–	–	–	–
Markovian Returns	12.2	23.6	9.2	17.2	6.7			
Entrepreneurial Returns	8.3	17.3	8.4	9.2	3.8			
Norway	3.8 (Private equity: 10)	14.2	8.6	7.7	6.0			

Notes: All statistics are wealth-weighted. Norwegian statistics from Fagereng, Guiso, Malacrino, Pistaferri (ECMA, 2020).

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Norway	3.8 (Private equity: 10)	14.2	8.6	7.7	6.0	4.3	11.6	23.4

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Return Heterogeneity and Entrepreneurship

	Cross-Section			Life-Time				
	Average	p90-p10	Std. Dev.	p90-p10	Std. Dev.	p90	p99	p99.9
PEER Model & Awesome State	3.0	–	–	–	–	–	–	–
Markovian Returns	12.2	23.6	9.2	17.2	6.7	8.3	15.6	19.8
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Notes: All statistics are wealth-weighted. Norwegian statistics from Fagereng, Guiso, Malacrino, Pistaferri (ECMA, 2020).

For Entrepreneurial Returns model:

- Entrepreneurship: **10.6% vs 11.5% in US** (Model: Entrep. Inc.>50% of Inc.; Data: Cagetti, DeNardi, 2006)
- Entrepreneurs hold 80% of wealth among top 1% wealth holders

What Aspects of Wealth Inequality to Match?

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3. **Life-cycle wealth dynamics** of super wealthy:
   - **55%** of US Forbes billionaires **are self-made** (see also Hubmer, Halvorsen, Salgado, Ozkan, 2024)
     $\rightarrow$ **10,000- to 20,000-fold increase in wealth** over 30-40 years.

Pareto Tail: Models vs US Data

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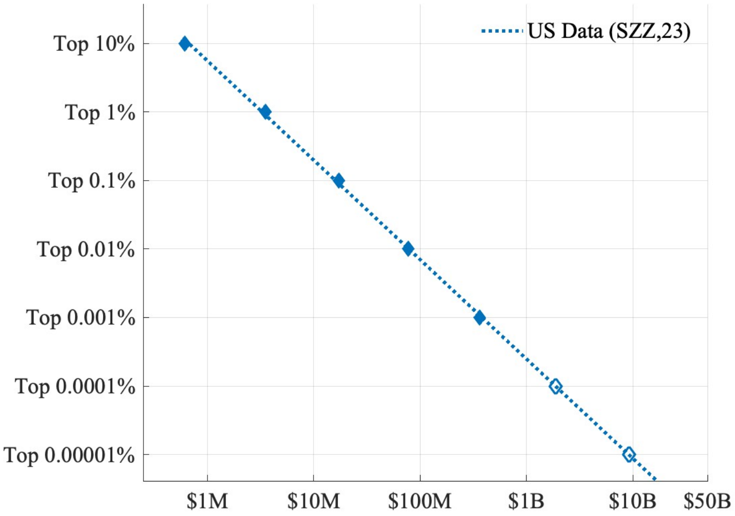

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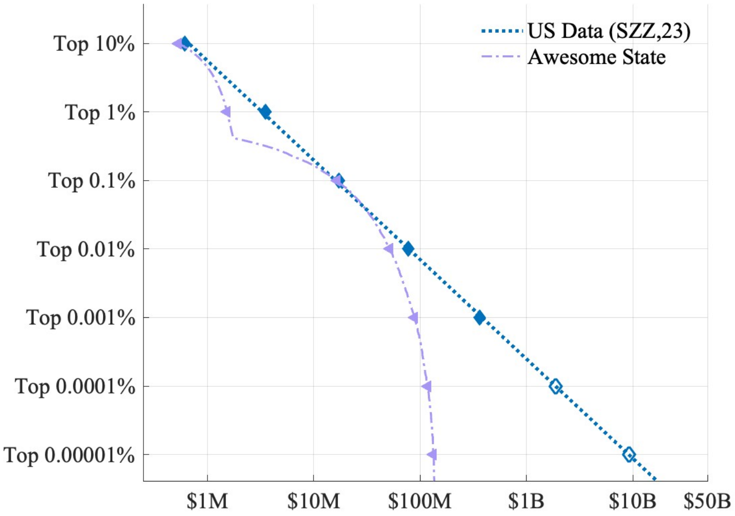

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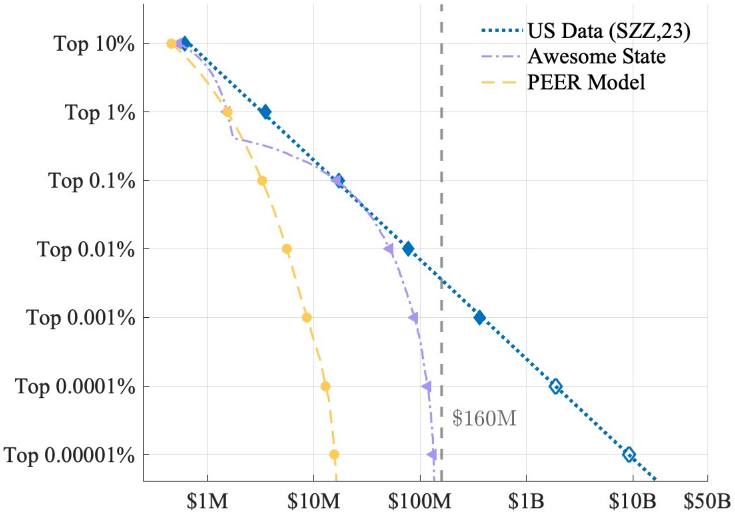
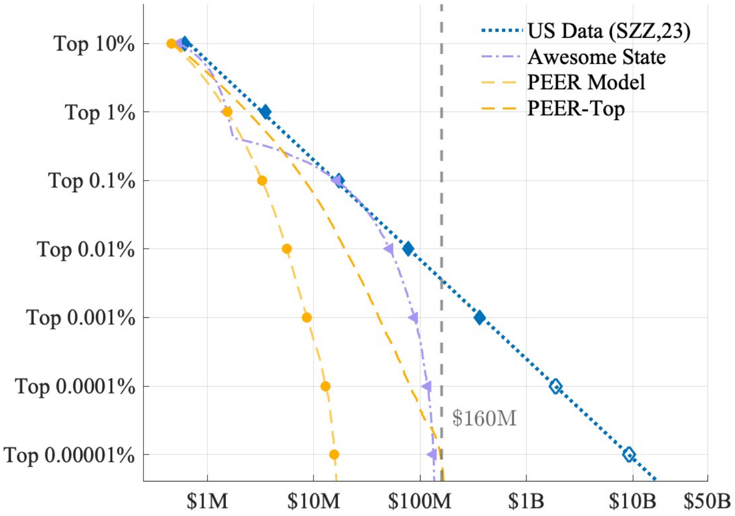


Pareto Tail: Models vs US Data

High R PEER



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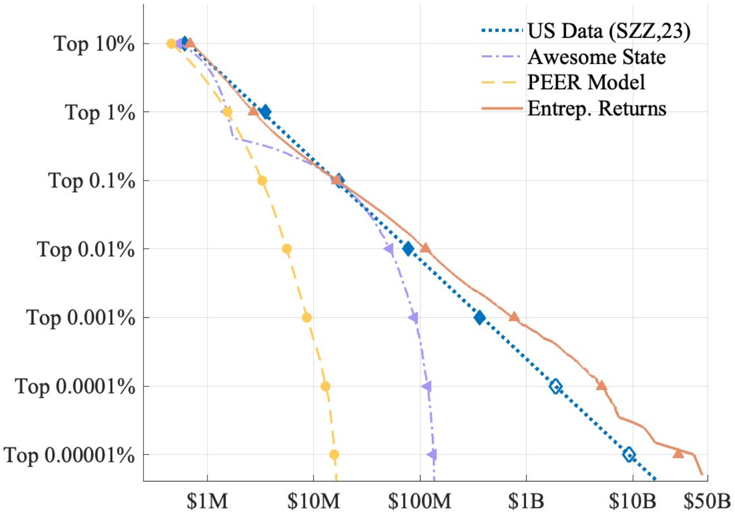
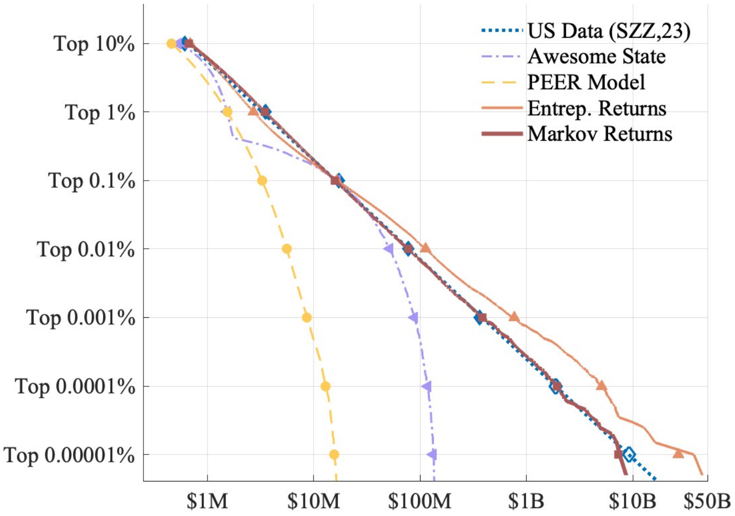


Pareto Tail: Models vs US Data

▸ Top Cutoffs



Wealth Inequality: Gini

	Frameworks				
	US Data	Awesome State	PEER Model	Return Heterogeneity	
				Markov	Entrepreneurial
Gini	**0.85**	0.84	0.72	0.79	0.78
Top 10%	68.6	71.5	54.2	67.3	64.6
Top 1%	33.7	30.0	13.5	31.5	34.9
Top 0.1%	15.7	15.4	2.5	14.8	22.2
Top 0.01%	7.1	3.3	0.4	7.0	13.0
% Self-made	55	0.4	0.0	0.0	57.5

Source: US Data from *Smith, Zidar, Zwick* (QJE, 2023) complemented with Forbes data.

Wealth Inequality: Top Shares

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* **Awesome-state model: only 0.002%** above **empirical 0.01% wealth threshold**. Millionaires

Wealth Inequality: Fraction Self-Made

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Top 0.01%	7.1	3.3	0.4	7.0	13.0	9.4
% Self-made	**55**	0.4	0.0	**0.0**	**57.5**	21.3

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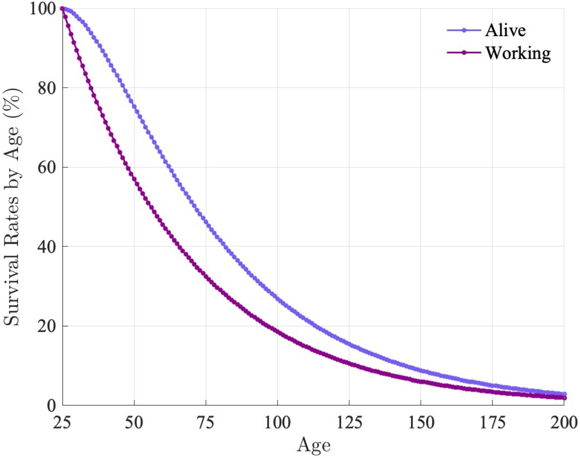
Age Distribution: Awesome-State Model



Notes: Perpetual-youth with constant probability of retiring of 1/45 and constant probability of dying after retirement of 1/15.

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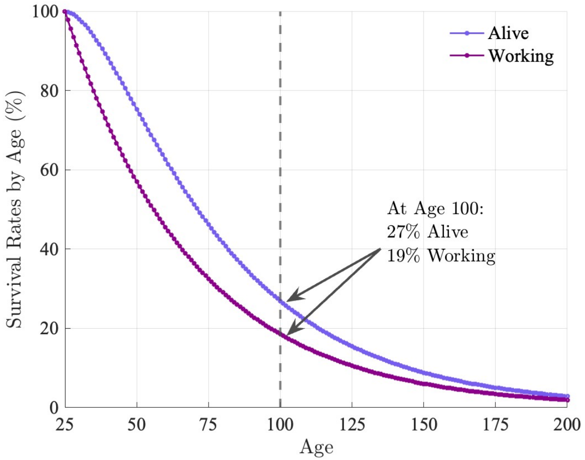

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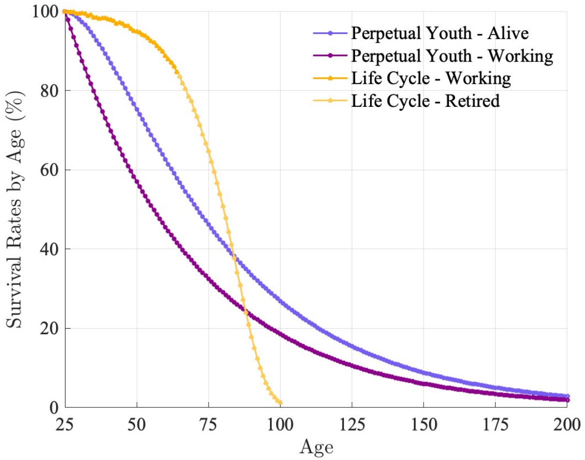
- US has 97,000 centenarians. **Or 0.029% of population**

US Data

Age Distribution: Awesome-State Model vs Life Cycle Models



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US Data

Who Holds the Wealth?

Wealth Age Profiles

Representation of the Very Old in **Top 1%**

	Awesome State		Markov Returns	
Age	Population Share	Wealth Share	Population Share	Wealth Share
65+	81.1	67.0	43.6	41.3
85+				
100+				
120+				

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65+	81.1	67.0	43.6	41.3
85+	73.6	50.8	3.7	3.7
100+	**61.2**	**39.1**	NA	NA
120+	**39.8**	**25.0**	NA	NA

Recap: Comparison of Models' Performance

		Pareto Tail		Overall Inequality	Lyfe Cycle Dynamics
Model:		Shape	Thickness	Gini + Top Shares	Self-made
1.	PEER model	No	No	No	No
2.	Awesome-State model	No	No	**Yes**	No
3.	Return heterogeneity	**Yes**	**Yes**	**Yes**	**Yes**

Conclusions

- **“Awesome-State”** Model:
  - Perpetual youth creates highly questionable demographics.
    - Centenarians hold 2/5 of top 1% wealth
  - Income process contradicts a large number of facts that are now well established.
  - Model does not generate a Pareto tail, and nobody has more than 150 million in wealth.

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- **PEER** Model:
  - Realistic income + demographics go some way toward creating high wealth inequality
  - Minimal effect of top 1% wealth holdings and beyond.
- **“Rate of Return Heterogeneity”** Model:
  - Matches salient features of the wealth distribution with empirically reasonable returns.
  - Substantially different & interesting policy implications (than Aiyagari framework).

APPENDIX

Limited effect of saving rates with finite lives

back

Simple wealth accumulation process:

$$w_{h+1} = R \cdot w_h + s \cdot y_h \longrightarrow w_h = R^h w_0 + \sum_{t=0}^{h-1} R^{h-1-t} s y_t$$

- Set $w_0 = \$1M$, $R = 1.03$, and $s = 1$
- High and constant income: $y_h = y$ with $y \in \{ p90 , p99 , p99.9\}$

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Takes over 100 years to accumulate $1B (even for the earnings-rich!)

Years to	Income		
	p90 ($108K)	p90 ($309K)	p99.9 ($927K)
$100M	106	78	48
$1B	183	153	118
$10B	260	230	195

Limited effect of saving rates with finite lives II

back

$w_{h+1} = R \cdot w_h + s \cdot y_h$ Set $R = 1.03;\ s = 1;$ High+Constant Income

Limited effect of saving rates with finite lives II

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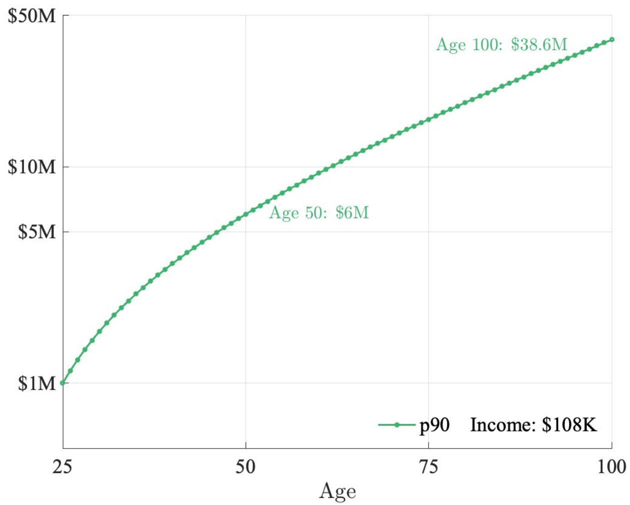
$$w_{h+1} = R \cdot w_h + s \cdot y_h \qquad \text{Set } R = 1.03;\ s = 1;\ \text{High+Constant Income}$$



Limited effect of saving rates with finite lives II

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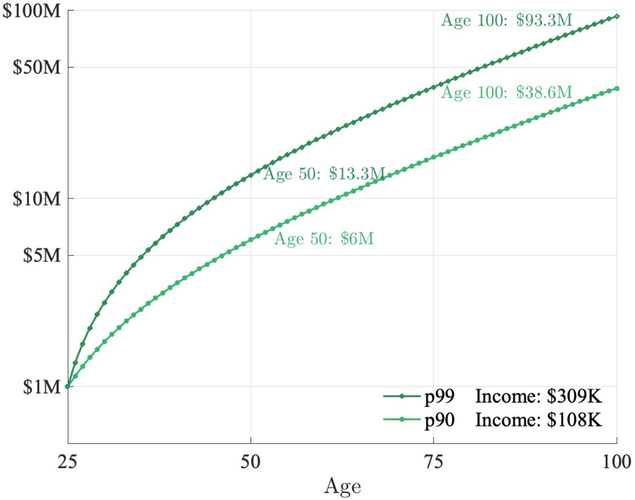

Limited effect of saving rates with finite lives II

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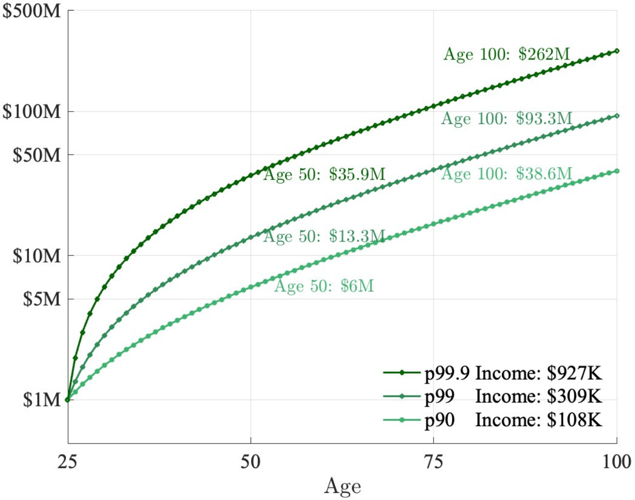
$$w_{h+1} = R \cdot w_h + s \cdot y_h \qquad \text{Set } R = 1.03; \; s = 1; \text{ High+Constant Income}$$



Labor Income, Returns, and Wealth Levels

back

- We fix average labor income (~\$60K) and the wealth to income ratio (4)

$$4 = \frac{W}{\text{Labor Income} + \text{Capital Income}}$$

  - Labor income = Working-Share $\times$ Avg. Labor Inc.

- Level of wealth depends on returns to wealth

$$4 = \frac{W}{\text{Labor Income} + R \times W} \longrightarrow W = \frac{4}{1 - 4 \times R} \times \text{Labor Income}$$

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	US Data	Awesome State $R = 3\%$	PEER $R = 3\%$	Markov Returns $R = 12\%$
Avg. Wealth	\$320K	\$200K	\$170K	\$330K

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  - Labor income = Working-Share $\times$ Avg. Labor Inc.

- Level of wealth depends on returns to wealth

$$4 = \frac{W}{\text{Labor Income} + R \times W} \longrightarrow W = \frac{4}{1 - 4 \times R} \times \text{Labor Income}$$

	US Data	Awesome State $R = 3\%$	PEER $R = 3\%$	Markov Returns $R = 12\%$
Avg. Wealth	\$320K	\$200K	\$170K	\$330K

- Wealth concentration results unchanged when matching average wealth

High R PEER

Empirical Benchmark Income Process (Guvenen et al, 2021, ECMA)

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$$\text{Level of earnings:} \quad \tilde{Y}_t^i = (1-\nu_t^i)e^{\left(g(t)+\alpha^i+\theta^i t+z_t^i+\varepsilon_t^i\right)} \tag{1}$$

$$\text{Persistent component:} \quad z_t^i = \rho z_{t-1}^i + \eta_t^i, \tag{2}$$

$$\text{Innovations to AR(1):} \quad \eta_t^i \sim \begin{cases} \mathcal{N}(\mu_{\eta,1}, \sigma_{\eta,1}) & \text{with prob. } p_z \\ \mathcal{N}(\mu_{\eta,2}, \sigma_{\eta,2}) & \text{with prob. } 1-p_z \end{cases} \tag{3}$$

$$\text{Initial condition of } z_t^i\text{:} \quad z_0^i \sim \mathcal{N}(0, \sigma_{z_0}) \tag{4}$$

$$\text{Transitory shock:} \quad \varepsilon_t^i \sim \begin{cases} \mathcal{N}(\mu_{\varepsilon,1}, \sigma_{\varepsilon,1}) & \text{with prob. } p_\varepsilon \\ \mathcal{N}(\mu_{\varepsilon,2}, \sigma_{\varepsilon,2}) & \text{with prob. } 1-p_\varepsilon \end{cases} \tag{5}$$

$$\text{Nonemployment duration:} \quad \nu_t^i \sim \begin{cases} 0 & \text{with prob. } 1-p_\nu(t,z_t^i) \\ \min\{1, F_{\text{exp}}(\varphi)\} & \text{with prob. } p_\nu(t,z_t^i) \end{cases} \tag{6}$$

$$\text{Prob of Nonemp. shock:} \quad p_\nu^i(t,z_t) = \frac{e^{\xi_t^i}}{1+e^{\xi_t^i}}, \text{ where } \xi_t^i \equiv a + bt + cz_t^i + dz_t^i t. \tag{7}$$

I.A. Income Inequality: Top Tail of Income Distribution

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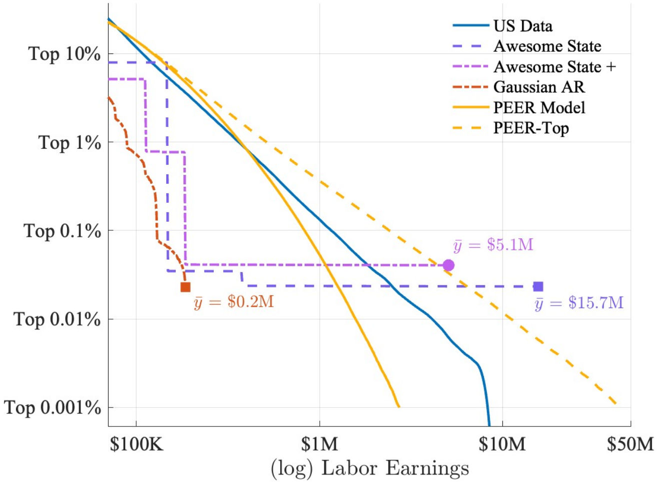
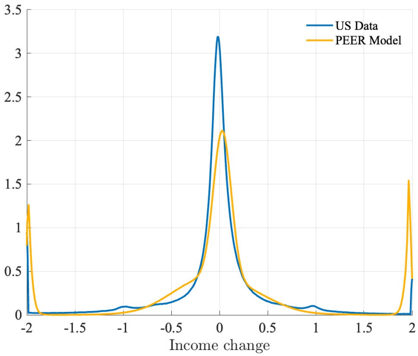


Income Risk: Density of Income Growth

back

Histogram of $\Delta \log Y$



Income Risk: Density of Income Growth

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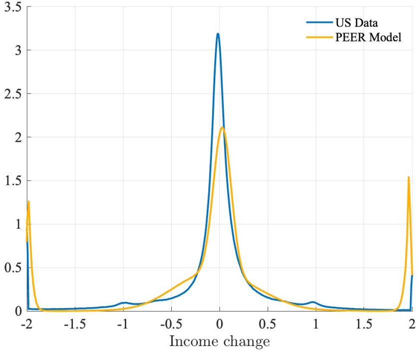

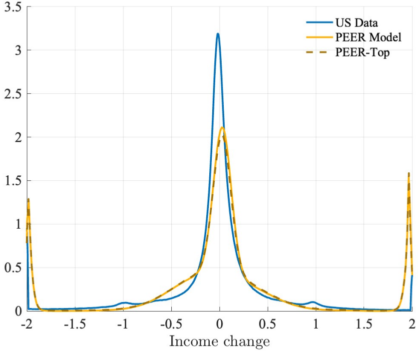

Income Risk: Density of Income Growth

back

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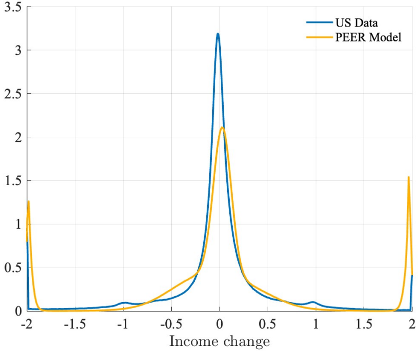

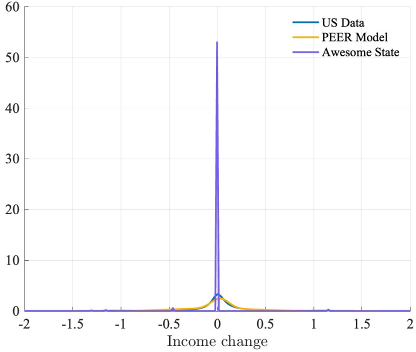

Income Risk: Density of Income Growth

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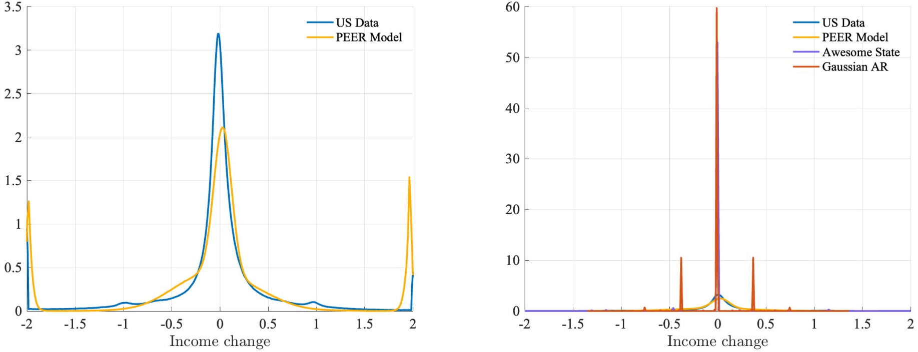
Histogram of $\Delta \log Y$



III.A Income Risk: Skewness of Income Growth

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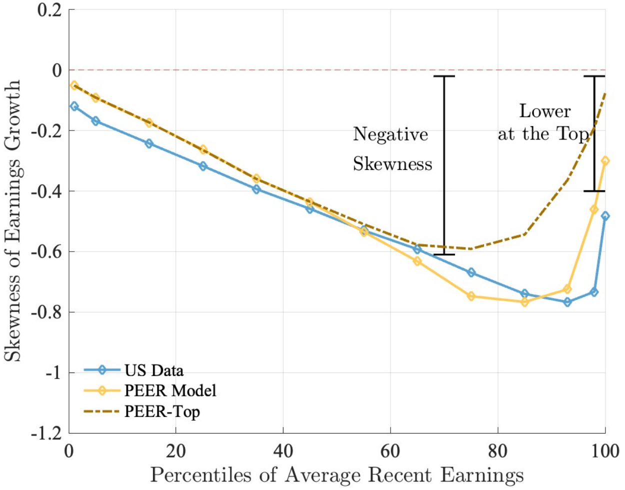

IV.A Income Risk: Kurtosis of Income Growth

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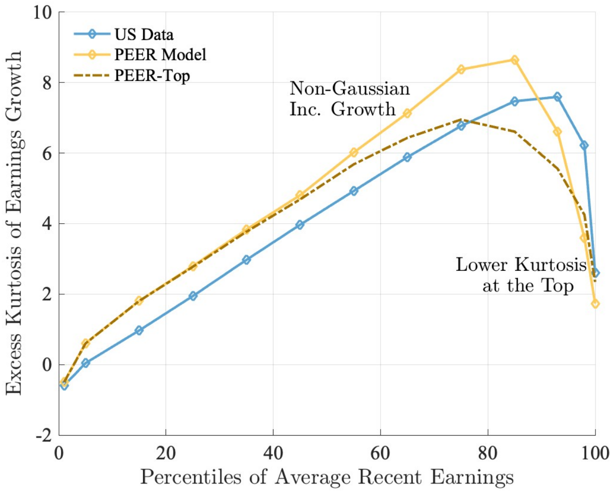

Increasing R to Match Wealth Levels

more back 1 back 2

- Calibrate PEER model with $R = 11\%$ + Wealth-to-income ratio of 4

Increasing R to Match Wealth Levels

more back 1 back 2

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	US Data	PEER	PEER-Top	PEER-Top + $R = 11\%$	Markov Returns
Avg. Wealth	\$320K	\$170K	\$200K	\$314K	\$330K

Increasing R to Match Wealth Levels

- Calibrate PEER model with $R = 11\%$ + Wealth-to-income ratio of 4

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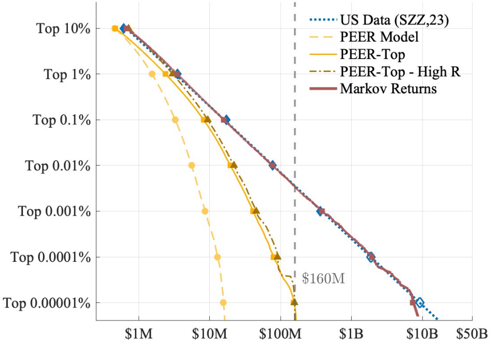

Wealth Inequality: PEER Model + PEER Top

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	Gini + Top Shares			Top Wealth Thresholds		
	US Data	PEER Model	PEER Top	**US Data**	PEER Model	PEER Top
Gini	**0.85**	0.72	0.79			
Top 10%	**68.6**	54.2	65.2	0.6	0.5	0.5
Top 1%	**33.7**	13.5	24.1	3.5	1.5	2.4
Top 0.1%	**15.7**	2.5	6.6	**17.2**	3.3	8.2
Top 0.01%	**7.1**	0.4	1.4	**77.8**	5.6	19.6

Source: US Data from *Smith, Zidar, Zwick* (QJE, 2023) complemented with Forbes data.

Where is the Top? Top Percentile Thresholds

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Cutoff Values in Millions of US Dollars

	US Data	Frameworks				
	Millions USD	Awesome State	PEER Model	Return Heterogeneity		
Threshold for top				Markov	Entrepreneurial	Markov +
1%	**3.5**	1.5	1.5	3.5	2.7	3.4
0.1%	**17.2**	16.5	3.2	15.9	16.5	13.4
0.01%	**77.8**	51.4	5.6	77.6	112.2	63.2

Source: US Data from *Smith, Zidar, Zwick* (QJE, 2023).

Where is the Top? Top Percentile Thresholds

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Millionaires in the Model: Population Above Data Cutoffs

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	US Data	Frameworks				
Cutoff (Millions USD)	Pop Share Above Cutoff	Awesome State	PEER Model	Return Heterogeneity		
				Markov	Entrepreneurial	Markov +
3.52	1.00	0.32	0.08	0.99	0.66	0.95

Source: US Data from *Smith, Zidar, Zwick* (QJE, 2023).

Millionaires in the Model: Population Above Data Cutoffs

back

Cutoff (Millions USD)	US Data	Frameworks				
	Pop Share Above Cutoff	Awesome State	PEER Model	Return Heterogeneity		
				Markov	Entrepreneurial	Markov +
3.52	1.00	0.32	0.08	0.99	0.66	0.95
17.2	0.10	0.09	0	0.09	0.10	0.07

Source: US Data from *Smith, Zidar, Zwick* (QJE, 2023).

Millionaires in the Model: Population Above Data Cutoffs

back

Cutoff (Millions USD)	US Data: Pop Share Above Cutoff	Frameworks: Awesome State	Frameworks: PEER Model	Return Heterogeneity: Markov	Return Heterogeneity: Entrepreneurial	Return Heterogeneity: Markov +
3.52	1.00	0.32	0.08	0.99	0.66	0.95
17.2	0.10	0.09	0	0.09	0.10	0.07
77.8	0.01	0.002	0	0.010	0.017	0.008

Source: US Data from *Smith, Zidar, Zwick* (QJE, 2023).

Wealth, Capital Income, and Consumption

top zoom back

- How concentrated are capital income and consumption relative to wealth?

Wealth, Capital Income, and Consumption

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Lorenz: Consumption is less concentrated than wealth; Capital income is more

Wealth, Capital Income, and Consumption

top zoom back

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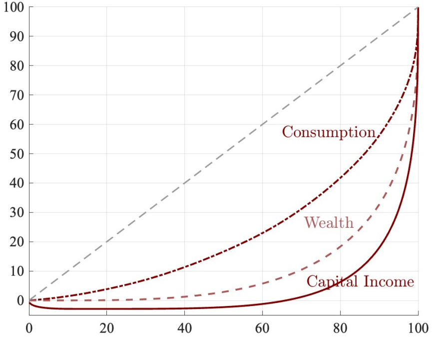
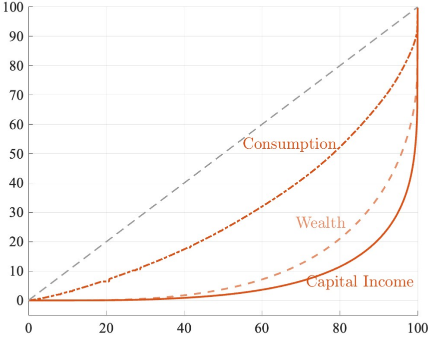
Markov Returns



Entrepreneurial Returns

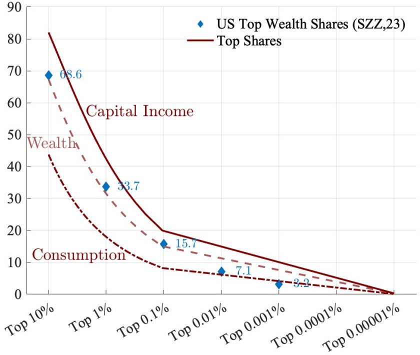


Wealth, Capital Income, and Consumption at the top

back

Top Shares: Consumption is less concentrated than wealth; Capital income is more

Markov Returns



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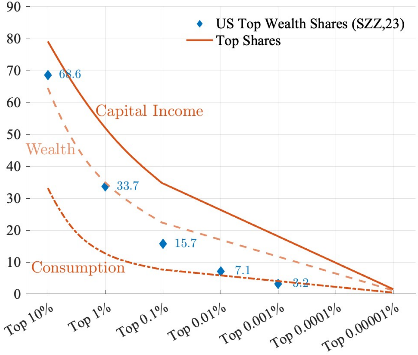

Age Distribution: US Data

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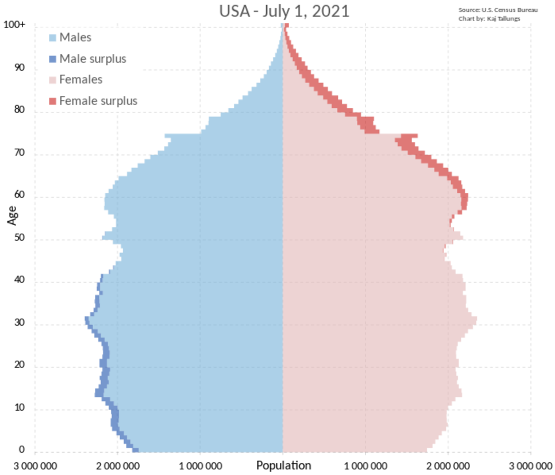
US has 97,000 centenarians. **Or 0.029% of population**



Average Lifecycle Wealth Profiles

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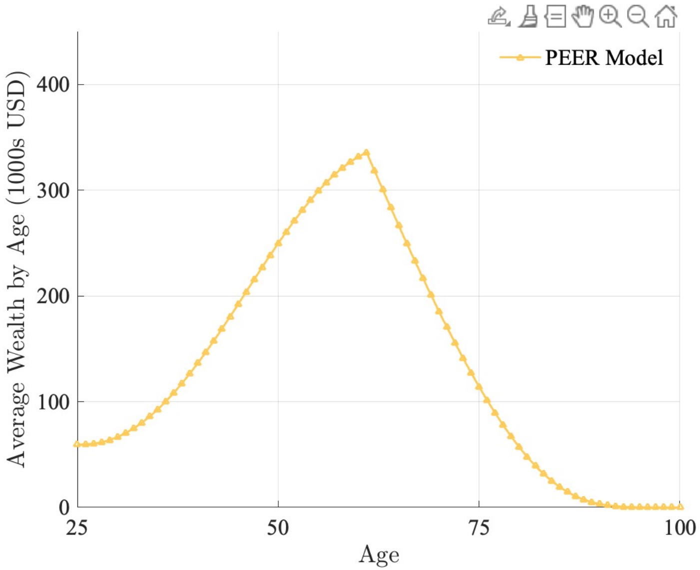

Average Lifecycle Wealth Profiles

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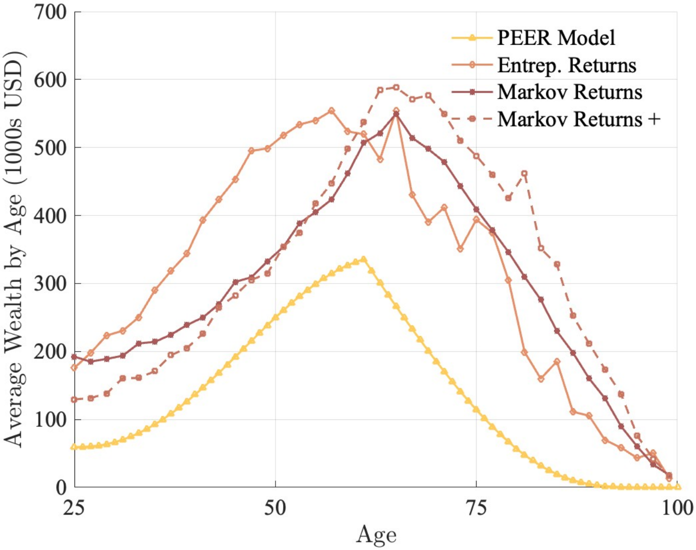

Average Lifecycle Wealth Profiles

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