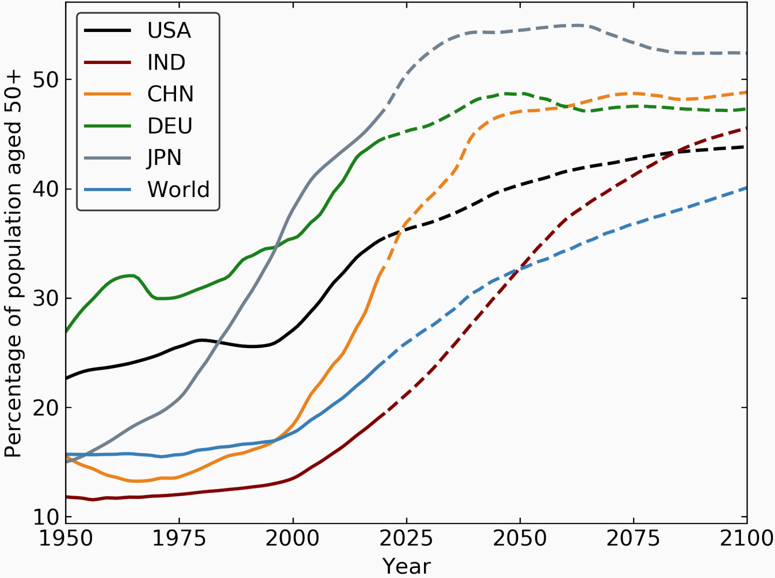
Demographics, Wealth, and Global Imbalances in the Twenty-First Century

Adrien Auclert, Hannes Malmberg, Frédéric Martenet and Matthew Rognlie

IMF, September 2021

The world population is aging...

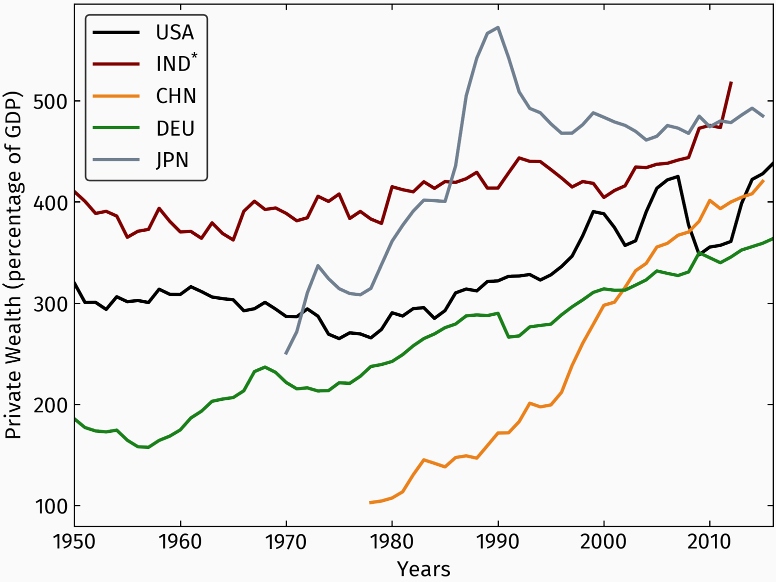


Source: 2019 United Nations World Population Prospects

...wealth-to-GDP ratios are increasing...

▸ National Wealth

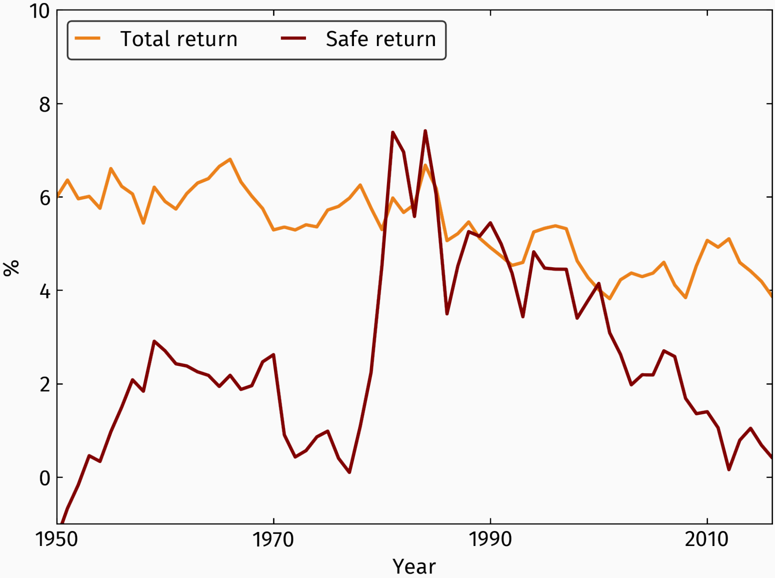
▸ SCF vs WID



*IND: National rather than Private Wealth. Source: World Inequality Database (WID)

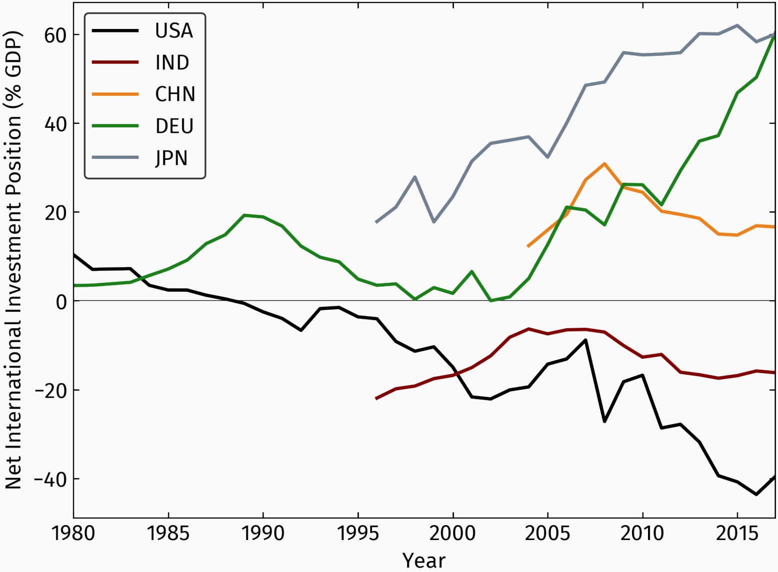
...rates of return on wealth are falling...

▸ Definitions



Source: National Accounts, Flow of Funds, WID.

…and “global imbalances” are rising



Source: International Monetary Fund (IMF), Penn World Table (PWT) 9.1

How will demographics shape these trends in the 21st century?

- Broad agreement that demographics has contributed to historical trends in W/Y, real returns (r), and NFA imbalances
    - Older population saves more, unevenly across countries

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- Influential view that these trends will revert:

  *"While a large population cohort that is saving for retirement puts upward pressure on the total savings rate, **a large elderly cohort may push down aggregate savings** by running down accumulated wealth."*

  [Lane 2020]

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  "**asset market meltdown**" hypothesis [Poterba 2001]

  "**great demographic reversal**" hypothesis [Goodhart-Pradhan 2020]

This paper: a sufficient statistic approach to this question

In a baseline multi-country GE OLG model, the effect of demographic change on W/Y, r and NFA depends **only** on:

1. Age profiles of wealth, labor income, and consumption
2. Demographic projections
3. The elasticity of intertemporal substitution σ
4. The elasticity of substitution between capital and labor η

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Conclusions are robust to quantitative simulations of richer model

A bridge between reduced-form and structural approaches

- Existing literature follows two broad approaches:

1. **Reduced-form**, based on shift-share exercises
    - Projected asset demand [Poterba 2001, Mankiw-Weil 1989], projected savings rates [Summers-Carroll 1987, Auerbach-Kotlikoff 1990...]
    - Projected labor supply [Cutler et al 1990], demographic dividend literature [Bloom-Canning-Sevilla 2003...]
2. **Structural**, based on fully specified GE OLG models
    - Demographics and **wealth** + social security [Auerback Kotlikoff 1987, İmrohoroğlu-İmrohoroğlu-Joines 1995, De Nardi-İmrohoroğlu-Sargent 2001, Abel 2003, Geanakoplos-Magill-Quinzii 2004, Kitao 2014...]
    - Demographics and **interest rates** [Carvalho-Ferrero-Necchio 2016, Gagnon-Johannsen-Lopez Salido 2016, Eggertsson-Mehrotra-Robbins 2019, Lisack-Sajedi-Thwaites 2017, Jones 2018, Papetti 2019, Rachel-Summers 2019...]
    - Demographics and **capital flows** [Henriksen 2002, Domeij-Flodén 2006, Börsch-Supan-Ludwig-Winter 2006, Krueger-Ludwig 2007, Backus-Cooley -Henriksen 2014, Bárány-Coeurdacier-Guibaud 2019, Sposi 2021...]

- **Sufficient statistic approach** bridges the gap between both

Baseline model

Environment: demographics, production, and government

OLG model, demographic change + multiple countries facing $\{r_t\}$

Demographics [drop country subscripts]

- Exogenous, time-varying sequence of births N_{0t}
- Exogenous, constant sequence of mortality rates ϕ_j ▸ Mortality contrib.
- No migration

Production

- Aggregate production function with capital and effective labor, with elasticity of substitution η
- Constant growth rate of labor-augmenting technology γ
- Perfect competition, free capital adjustment

Government

- Flow budget constraint

$$G_t + w_t \sum_{j=0}^{T} N_{jt} \mathbb{E} tr_j + (1 + r_t) B_t = \tau w_t \sum_{j=0}^{T} N_{jt} \mathbb{E} \ell_j + B_{t+1},$$

- Balance budget by changing G_t, not τ_t or tr_{jt}, to keep $B_t / Y_t \equiv \mathrm{cst}$

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Environment: heterogeneous agents

Problem for **heterogeneous agents** of cohort k (age $j \equiv t - k$)

$$\max \mathbb{E}_k \left[\sum_j \beta_j \Phi_j \frac{c_{jt}^{1-\frac{1}{\sigma}}}{1 - \frac{1}{\sigma}} \right]$$

$$\begin{aligned} s.t \quad & c_{jt} + \phi_j a_{j+1,t+1} \leq w_t((1-\tau)\ell(z_j) + tr(z^j)) + (1 + r_t) a_{jt} \\ & a_{j+1,t+1} \geq -\underline{a} \, (1+\gamma)^t \end{aligned}$$

- $\sigma \equiv$ elasticity of intertemporal substitution
- β_j: age-specific discount rate
- Φ_j: survival probability by age ($\Phi_j = \prod_j \phi_j$)
- $\ell(z_t)$: risky labor supply driven by arbitrary stochastic process z_t
- $\tau, tr(z^j)$: taxes and (state-contingent) government transfers
- a_{jt}: annuity holdings

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Equilibrium

Given demographics and policy, in an **integrated world equilibrium**:

- Individuals optimize
- Firms optimize
- Global asset markets clear

$$\sum_c W_t^c = \sum_c (K_t^c + B_t^c) \quad \forall t$$

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Next: consider small country aging alone, with world at steady state

→ r constant (will adjust later)

Compositional effects as sufficient statistics

Proposition

The wealth-to-GDP ratio of a small country aging alone with constant r and γ follows

$$\frac{W_t}{Y_t} \propto \frac{\sum_j \pi_{jt} a_{j0}}{\sum_j \pi_{jt} h_{j0}}$$

where $a_{j0} \equiv \mathbb{E}a_{j,0}$ and $h_{j0} = \mathbb{E}w_0 \ell_{j,0}$ are average initial asset holdings and pretax labor income by age, and $\pi_{jt} = N_{jt}/N_t$ is the share of the population of age j.

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$\Rightarrow$ change in log wealth to GDP ratio:

$$\log\left(\frac{W_t}{Y_t}\right) - \log\left(\frac{W_0}{Y_0}\right) = \log\left(\frac{\sum_j \pi_{jt} a_{j0}}{\sum_j \pi_{jt} h_{j0}}\right) - \log\left(\frac{\sum_j \pi_{j0} a_{j0}}{\sum_j \pi_{j0} h_{j0}}\right) \equiv \Delta_t^{comp}$$

measurable from demographic projections and hh. surveys

Why? Demographics do not affect (normalized) individual decisions

Measuring compositional effects

Measuring Δ^{comp}

- Calculate Δ_t^{comp} for 25 countries:

$$\Delta_t^{comp} \equiv \log\left(\frac{\sum \pi_{jt} a_{j0}}{\sum \pi_{jt} h_{j0}}\right) - \log\left(\frac{\sum \pi_{j0} a_{j0}}{\sum \pi_{j0} h_{j0}}\right)$$

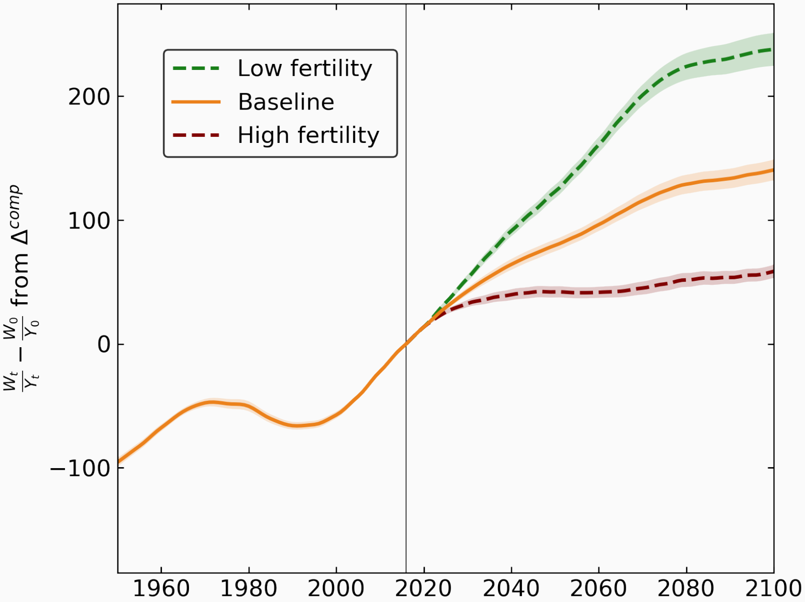
- Data:
  - π_{jt}: projections of age distributions over individuals

    2019 UN World Population Prospects
  - a_{j0}, h_{j0} age-wealth and labor income profiles in base year

    For US: SCF, LIS/CPS, and Sabelhaus-Henriques Volz (2019)
    a_{j0} includes funded part of DB pensions
    Household → individual (j) by splitting wealth among adults
- Report implied level change $\frac{W_t}{Y_t} - \frac{W_0}{Y_0} = \frac{W_0}{Y_0}\left(\exp\left\{\Delta_t^{comp}\right\} - 1\right)$

Δ^{comp} in the United States: 1950-2100

▸ Base year ▸ Historical



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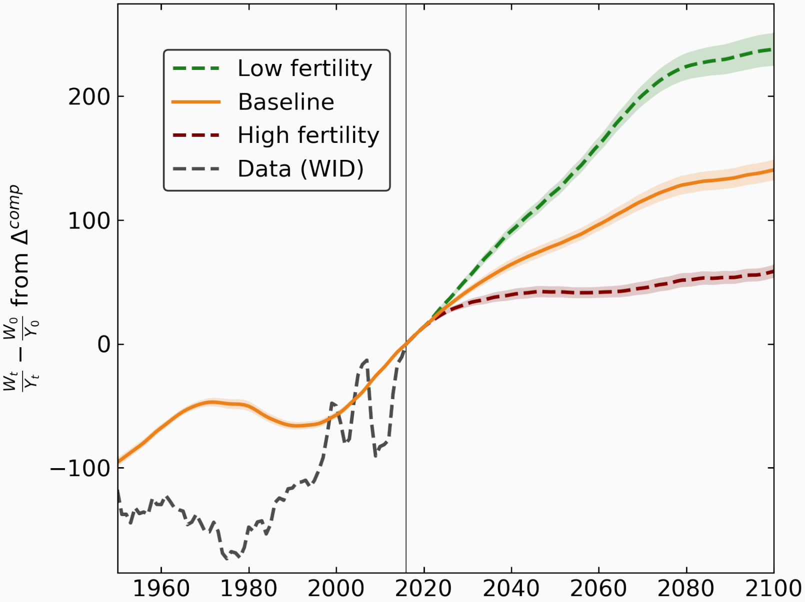
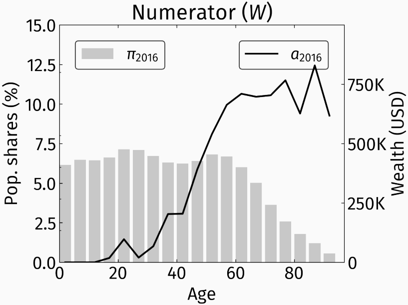


Where do these large effects come from?

Alt. profiles



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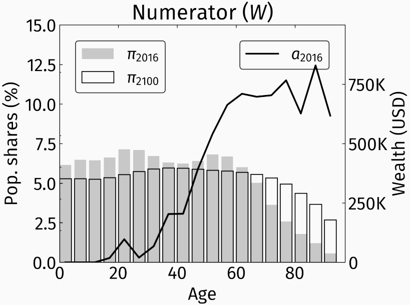

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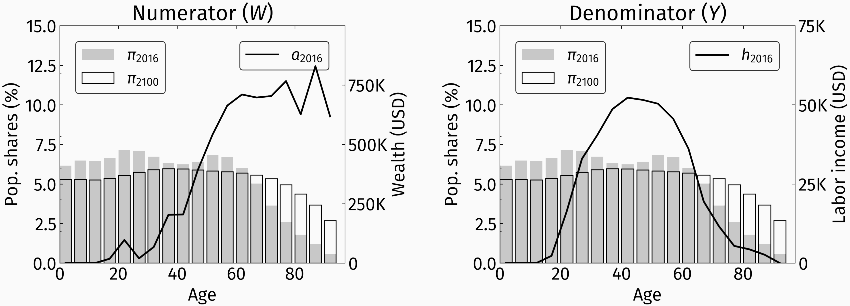

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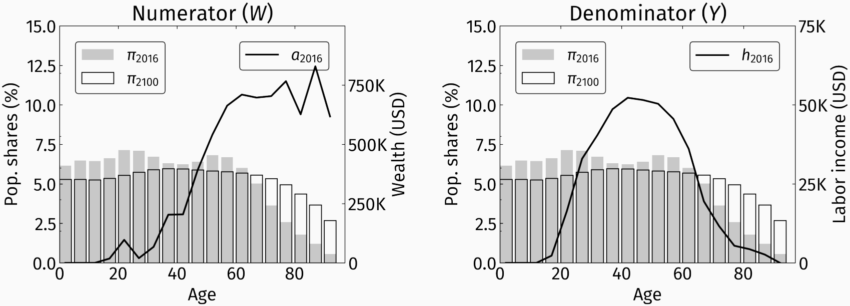
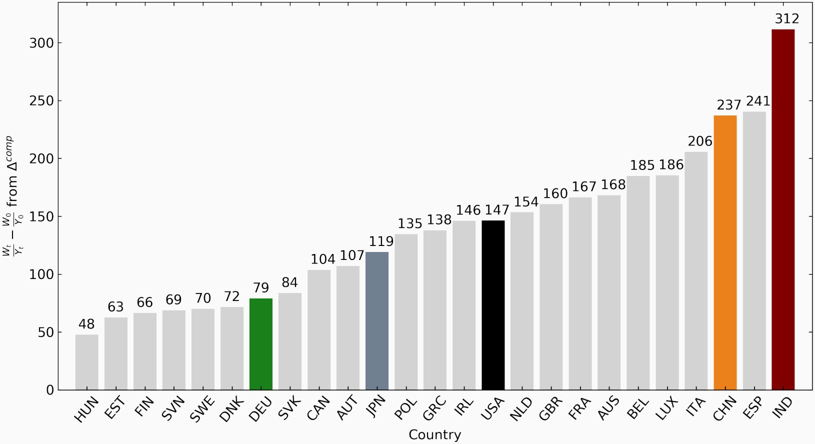


- In paper: separate contribution of numerator and denominator
  - Going forward: W contributes $\sim 2/3$, Y contributes $\sim 1/3$
  - Historically demographic dividend pushed Y up, reversed in 2010

Across countries, Δ^{comp} large and heterogeneous by 2100



General equilibrium implications

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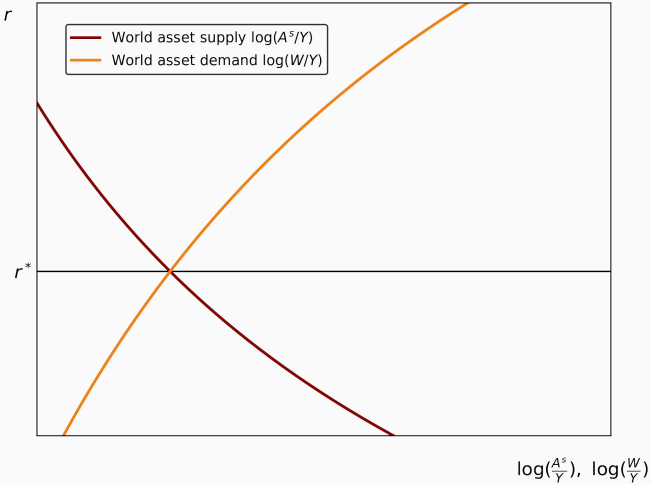
▸ Semielasticity formulas



Semielasticity of asset demand $\overline{\epsilon}_d$: depends on σ and observables

Semielasticity of asset supply $\overline{\epsilon}_s$: depends on η and observables

General equilibrium implications

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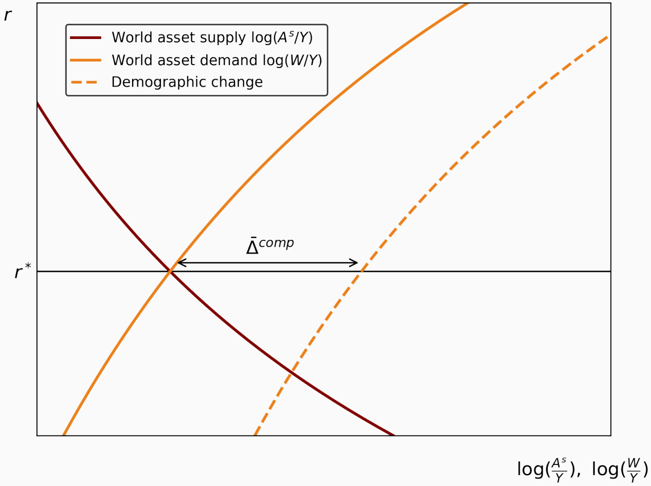
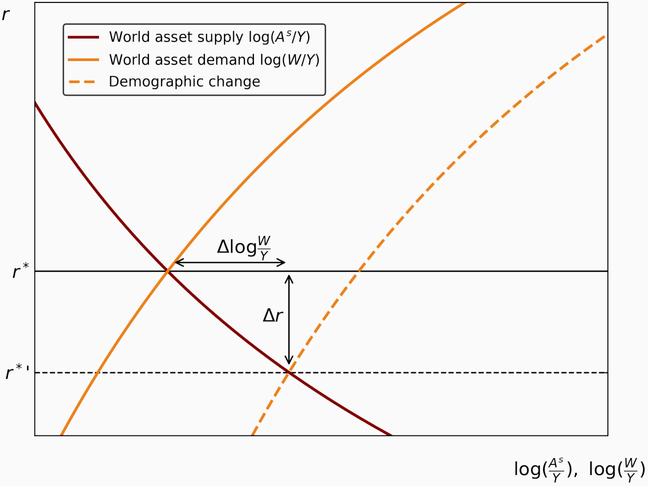


Asset demand shift of $\bar{\Delta}^{comp}$: wealth-weighted average of $\Delta^{comp,c}$

Large and positive in the data.

General equilibrium implications

▸ Semielasticity formulas



$$\Delta r \approx -\frac{\bar{\Delta}^{comp}}{\bar{\epsilon}_s + \bar{\epsilon}_d} < 0, \quad \overline{\Delta \log \left(\frac{W}{Y}\right)} \approx \frac{\bar{\epsilon}_s}{\bar{\epsilon}_s + \bar{\epsilon}_d} \bar{\Delta}^{comp} > 0$$

Changes in r and W/Y: 2016 to 2100

▸ General model

$$\Delta r \approx -\frac{\bar{\Delta}^{comp}}{\bar{\epsilon}^d + \bar{\epsilon}^s} \qquad \overline{\Delta \log\left(\frac{W}{Y}\right)} \approx \frac{\bar{\epsilon}^s}{\bar{\epsilon}^d + \bar{\epsilon}^s}\bar{\Delta}^{comp}$$

A. Change in world r

	σ		
η	0.25	0.50	1.00
0.60	-3.03	-1.56	-0.79
1.00	-2.00	-1.23	-0.70
1.25	-1.65	-1.09	-0.65

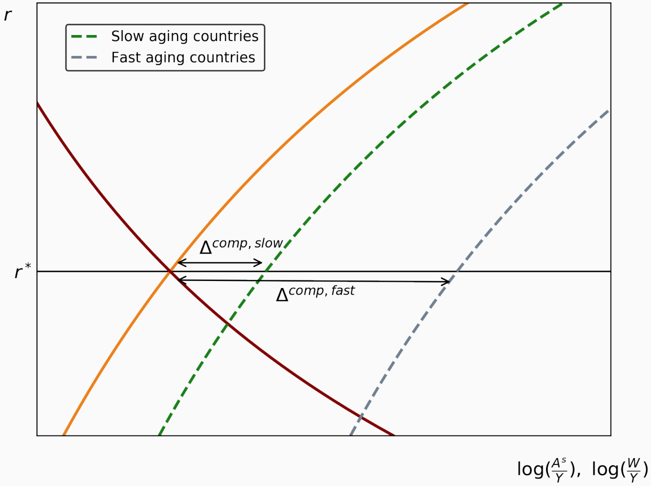
B. Change in avg. $\log W/Y$

	σ		
η	0.25	0.50	1.00
0.60	14.6	7.5	3.8
1.00	16.0	9.9	5.6
1.25	16.5	10.9	6.5

- Simulations of general model deliver very similar outcomes

General equilibrium implications, part 2

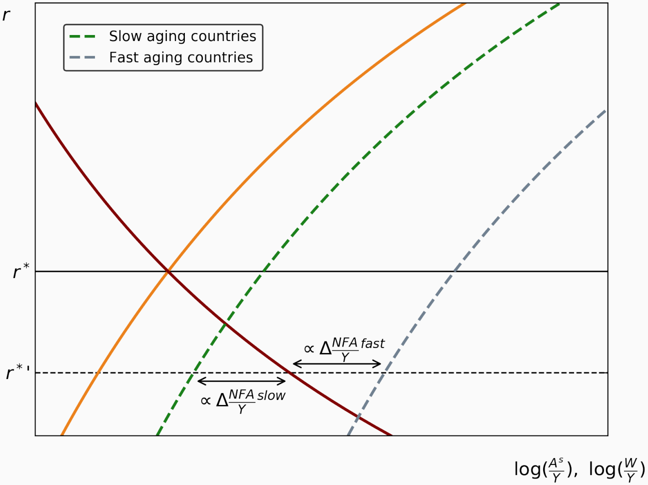
▸ Semielasticity formulas



Country-specific shifts Δ^{comp} large and heterogeneous in data

General equilibrium implications, part 2

▸ Semielasticity formulas

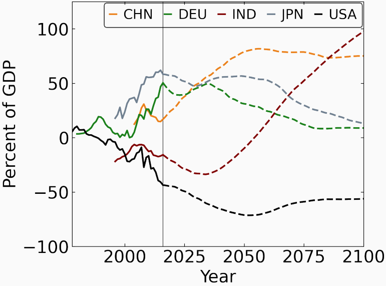


$$\Delta\left(\frac{NFA}{Y}\right) \approx \frac{W_0}{Y_0}\left(\Delta^{comp} - \bar{\Delta}^{comp}\right)$$

Demeaned compositional effect and NFAs

$$\Delta\left(\frac{NFA^c}{Y^c}\right) \simeq \frac{W_0^c}{Y_0^c}\left(\Delta_t^c - \bar{\Delta}_{comp}\right)$$

A. NFA projection



→ Data suggests large global imbalances for the 21st century

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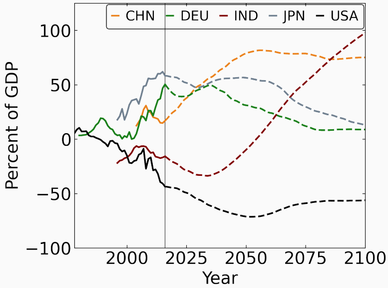
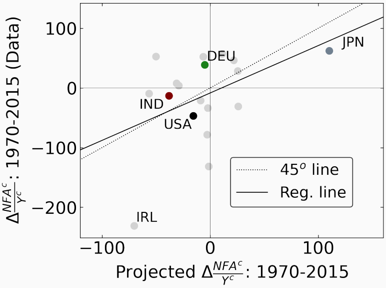


B. Historical performance

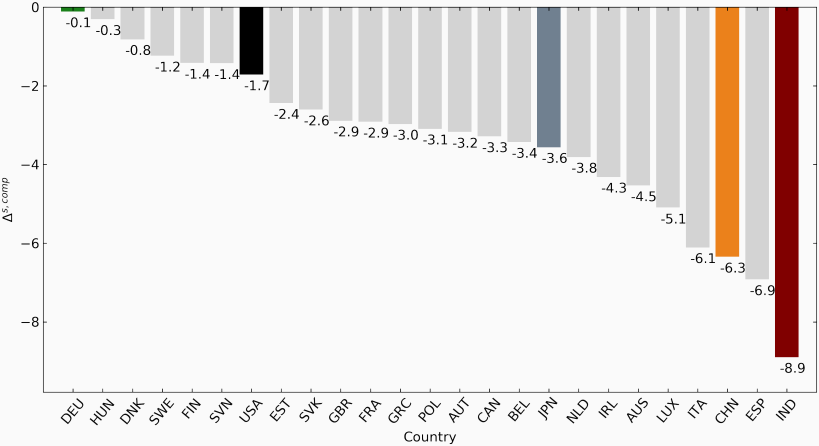


→ Data suggests large global imbalances for the 21st century

A great demographic reversal?

Worldwide: decreasing S_t/Y_t everywhere

- Perform same exercise, but projecting S/Y from composition



Declining *r* despite falling savings?

- Will dissaving of the old reverse the effects of demographics?
  [Lane 2020, Goodhart-Pradhan 2020, Mian-Straub-Sufi 2021]
- Measured S_t/Y_t from composition does decline
- **But**: *r* does not increase

Declining r despite falling savings?

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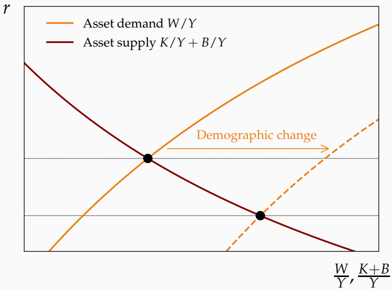
- Measured S_t/Y_t from composition does decline
- **But**: r does not increase
- Why? Savings is misleading with declining pop. growth. In s.s.:

  $$\frac{W}{Y} = \frac{S/Y}{g}$$

  where g is GDP growth
- With demographic change, S/Y falls, but g falls by more!

Flows can give the wrong sign for the change in r!

A. Asset demand vs supply



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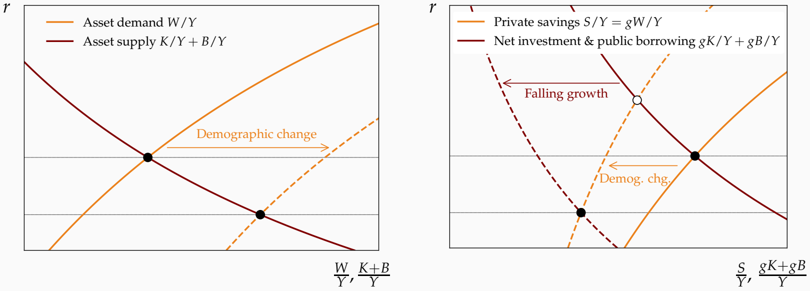


A. Asset demand vs supply

B. Net savings vs investment

Conclusion

- How does population aging affect wealth-output ratios, real interest rates, and capital flows?

  $\rightarrow$ what matters is the compositional effect Δ^{comp}

  large and **heterogeneous** in the data

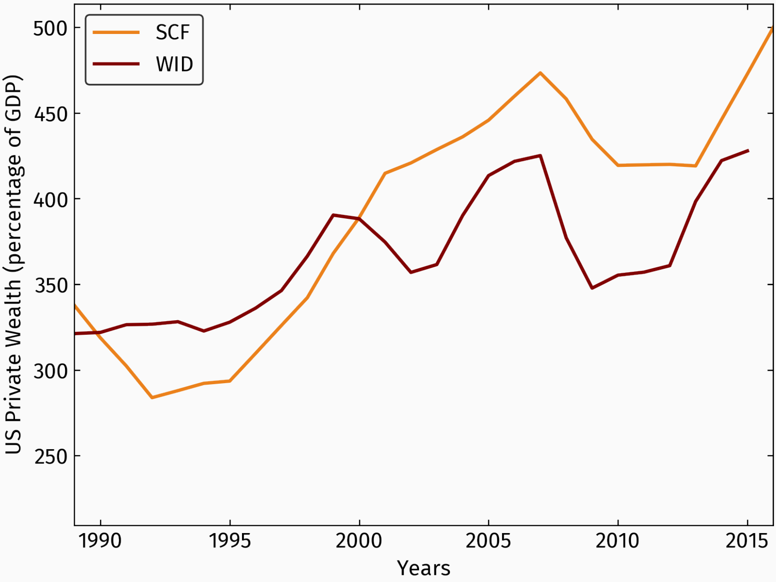
- For the 21st century, our approach:
  - Refutes the asset market meltdown hypothesis: r definitively falls
  - Suggests the global savings glut has just begun

Thank you!

Additional slides

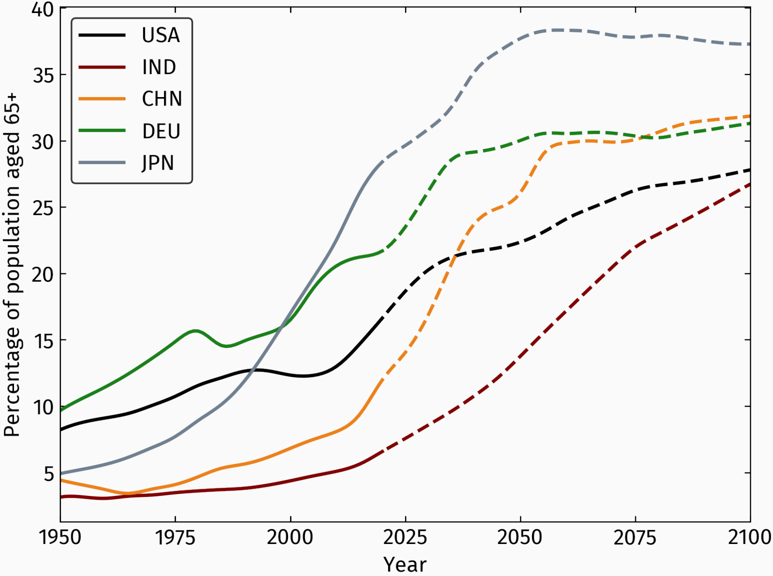
US Wealth-to-GDP from SCF vs World Inequality Database

Back



Source: World Inequality Database (WID), Survey of Consumer Finances (SCF)

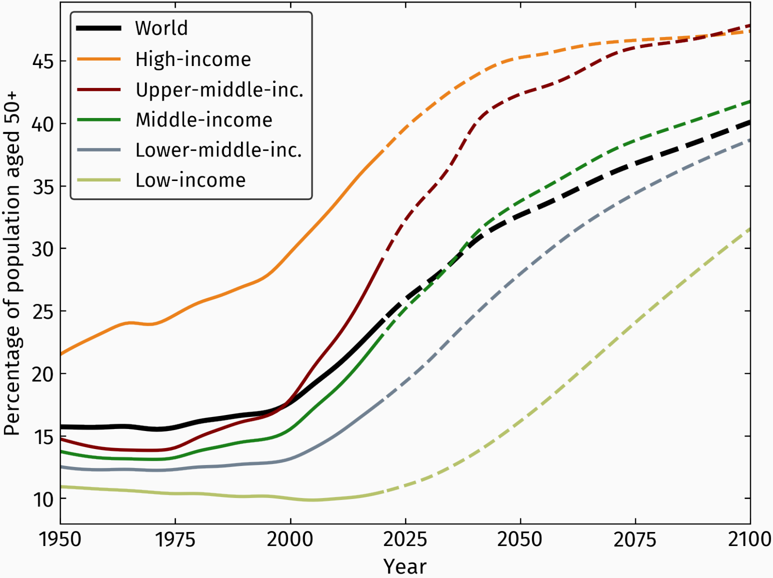
Share of the population aged 65+



Source: 2019 United Nations World Population Prospects

Countries by income group

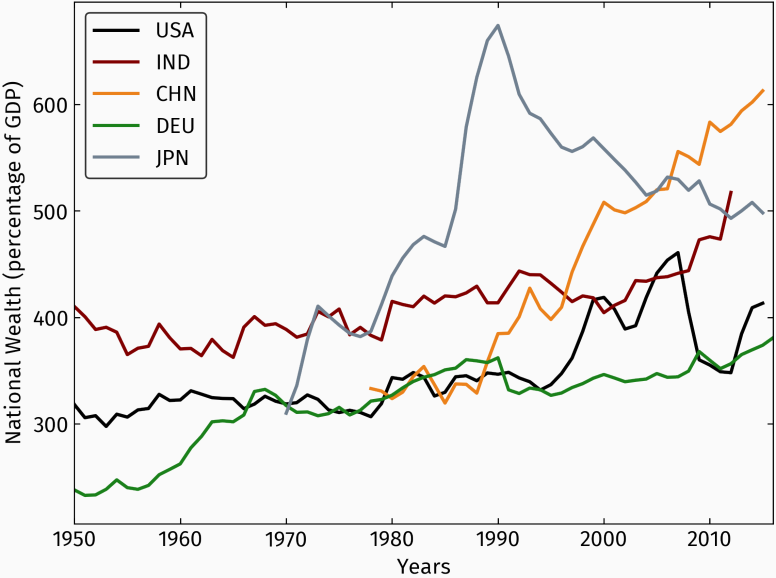
◂ Back



Source: 2019 United Nations World Population Prospects

National Wealth over GDP

Back



Source: World Inequality Database (WID)

Rates of return on wealth

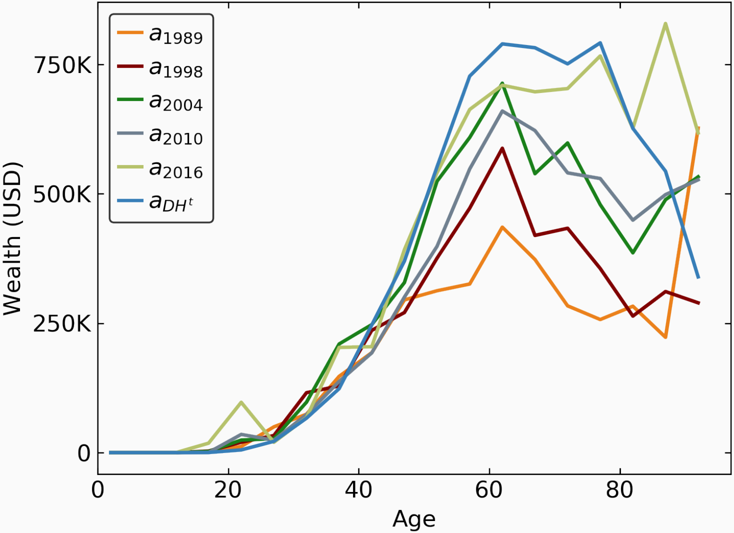
◂ Back

- Baseline safe return r_t^{safe} is 10 year constant maturity interest rate minus HP-filtered PCE deflator
- Baseline total return is

$$r_t = \frac{(s_K Y - \delta K)_t + r_t^{safe} B_t}{W_t - NFA_t}$$

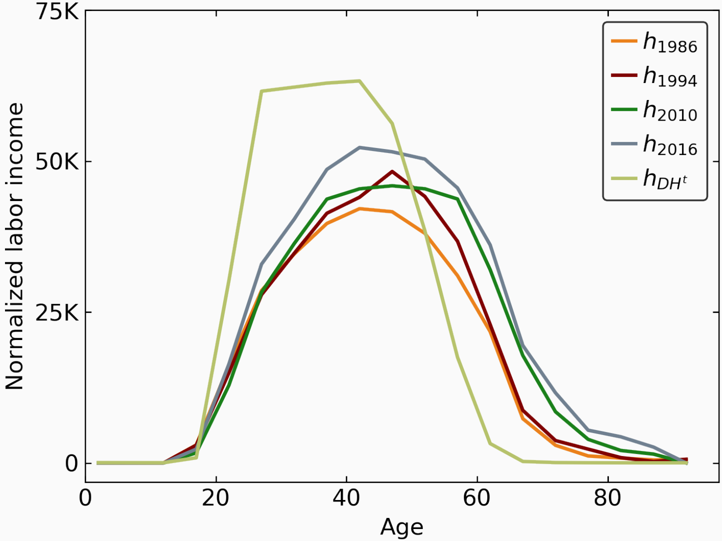
where $(s_K Y - \delta K)_t$ is net capital income

Age-wealth profiles in the U.S.



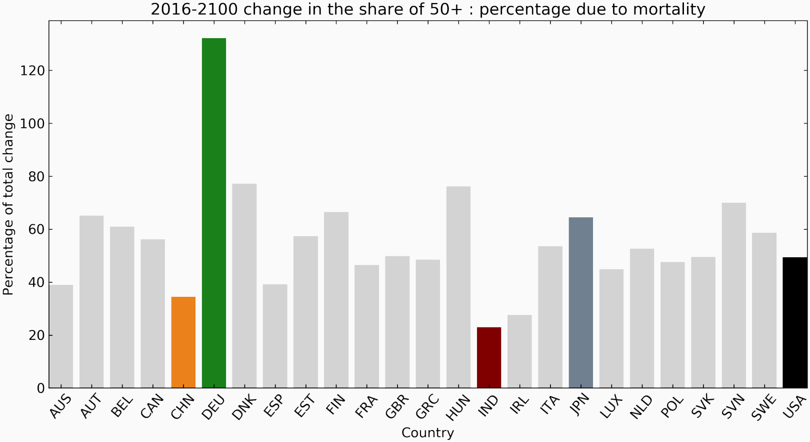
Age-labor income profiles in the U.S.

Back



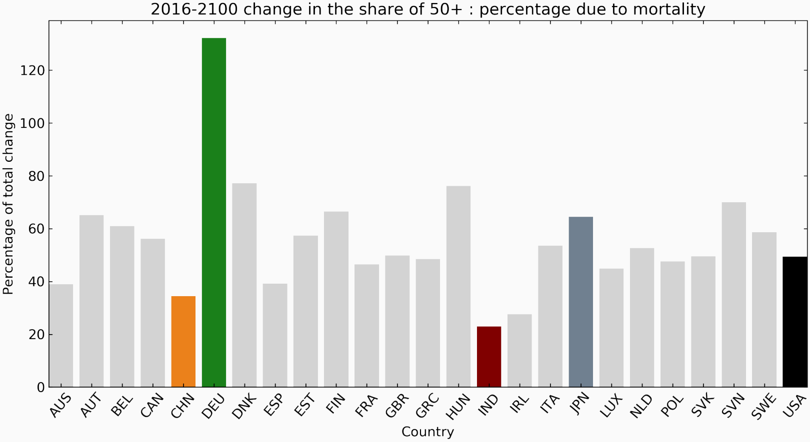
Contribution of mortality to aging since 1950

Back

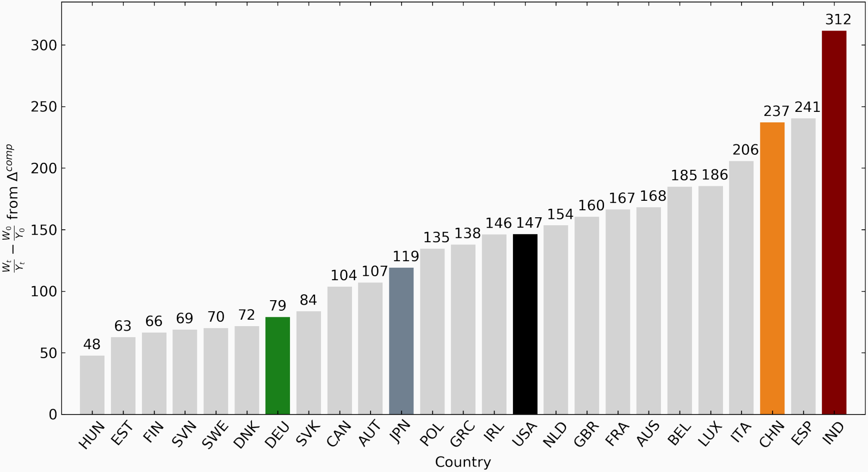


Contribution of mortality to aging in 21st century

◂ Back

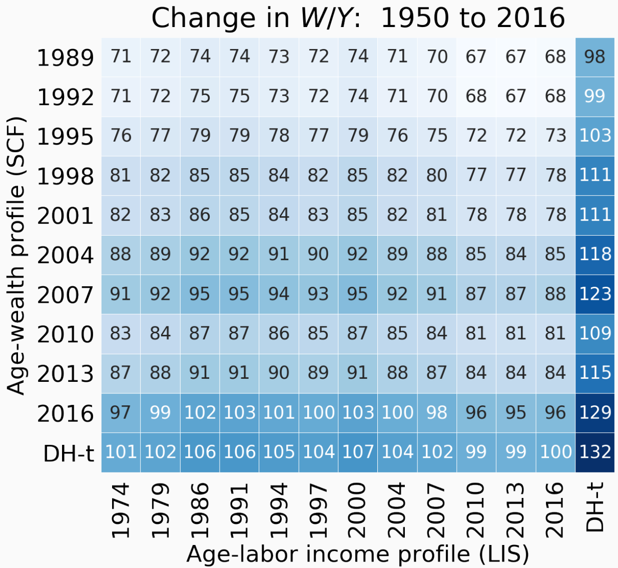


Δ^{comp} around the world in 2100



Robustness to baseline year for age profiles (past)

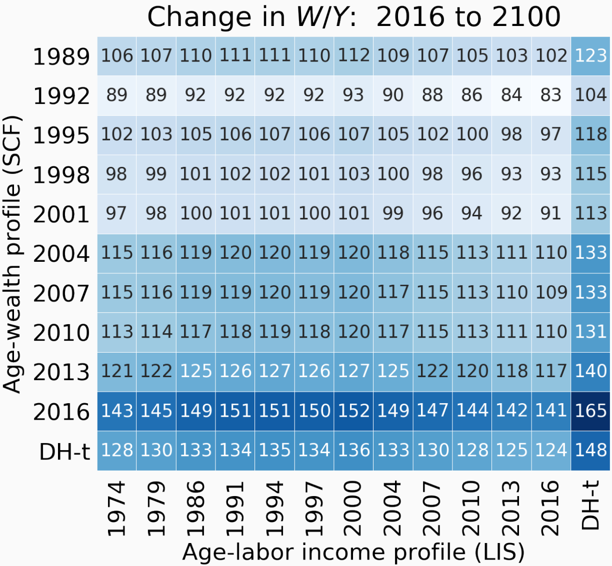
Back


Change in W/Y: 1950 to 2016

	1974	1979	1986	1991	1994	1997	2000	2004	2007	2010	2013	2016	DH-t
1989	71	72	74	74	73	72	74	71	70	67	67	68	98
1992	71	72	75	75	73	72	74	71	70	68	67	68	99
1995	76	77	79	79	78	77	79	76	75	72	72	73	103
1998	81	82	85	85	84	82	85	82	80	77	77	78	111
2001	82	83	86	85	84	83	85	82	81	78	78	78	111
2004	88	89	92	92	91	90	92	89	88	85	84	85	118
2007	91	92	95	95	94	93	95	92	91	87	87	88	123
2010	83	84	87	87	86	85	87	85	84	81	81	81	109
2013	87	88	91	91	90	89	91	88	87	84	84	84	115
2016	97	99	102	103	101	100	103	100	98	96	95	96	129
DH-t	101	102	106	106	105	104	107	104	102	99	99	100	132

Robustness to baseline year for age profiles (future)

Back



Change in *W/Y*: 2016 to 2100

Age-wealth profile (SCF) \ Age-labor income profile (LIS)	1974	1979	1986	1991	1994	1997	2000	2004	2007	2010	2013	2016	DH-t
1989	106	107	110	111	111	110	112	109	107	105	103	102	123
1992	89	89	92	92	92	92	93	90	88	86	84	83	104
1995	102	103	105	106	107	106	107	105	102	100	98	97	118
1998	98	99	101	102	102	101	103	100	98	96	93	93	115
2001	97	98	100	101	101	100	101	99	96	94	92	91	113
2004	115	116	119	120	120	119	120	118	115	113	111	110	133
2007	115	116	119	119	120	119	120	117	115	113	110	109	133
2010	113	114	117	118	119	118	120	117	115	113	111	110	131
2013	121	122	125	126	127	126	127	125	122	120	118	117	140
2016	143	145	149	151	151	150	152	149	147	144	142	141	165
DH-t	128	130	133	134	135	134	136	133	130	128	125	124	148

Low and high fertility scenarios

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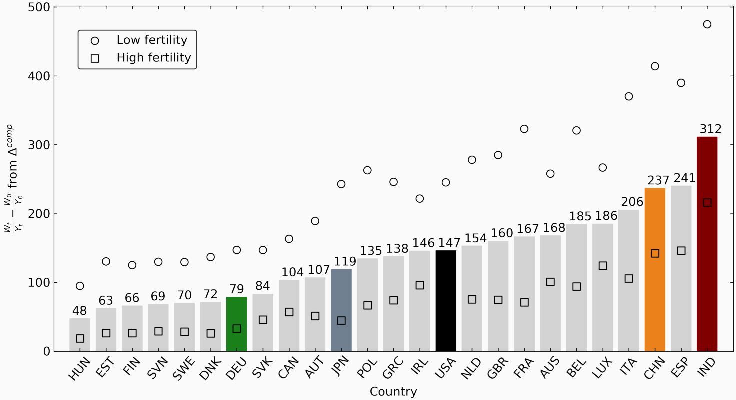
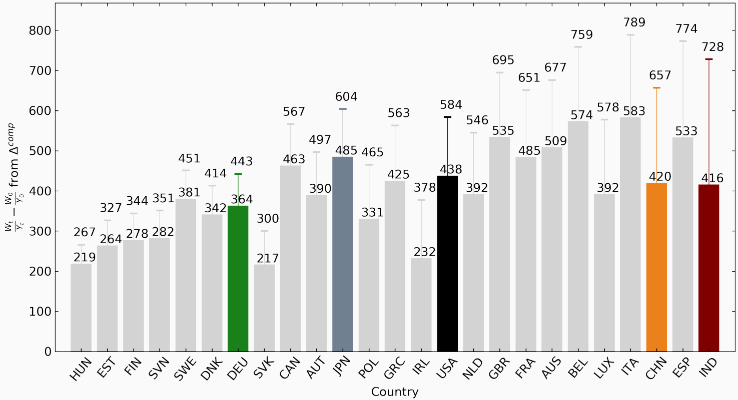


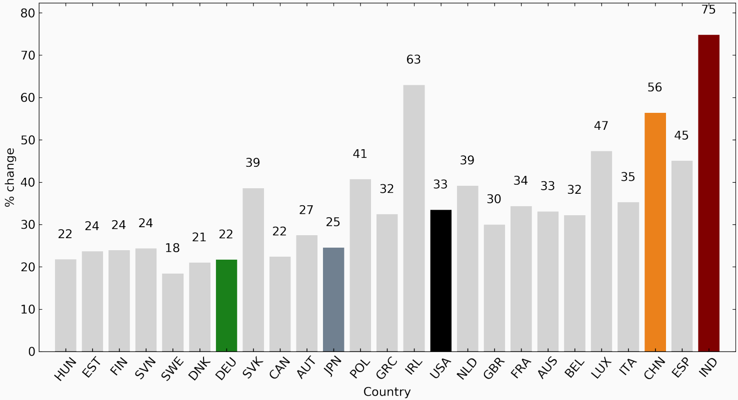
W/Y from comp. effect in 2016 and in 2100

Back



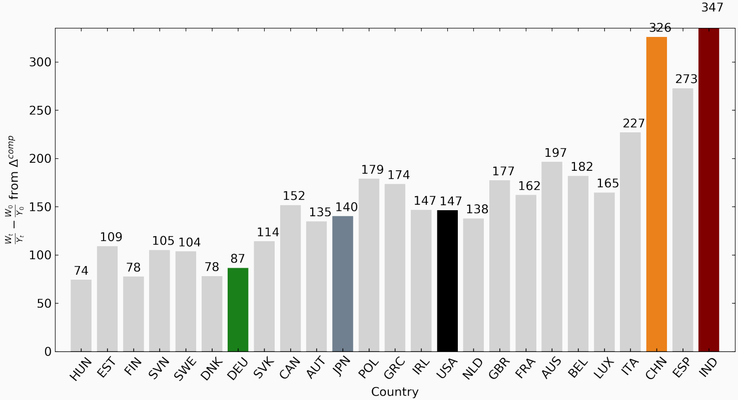
Percentage change in W/Y from comp. effect

◂ Back



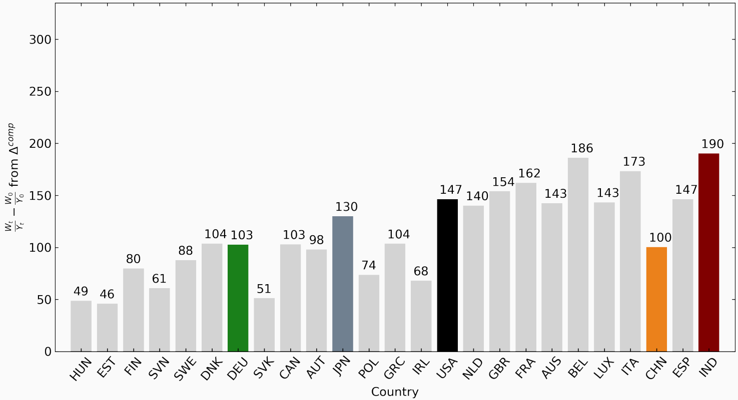
Compositional effect at common age profiles

◂ Back



Compositional effect at common demographic change

Back



Environment: demographics

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- Population evolves as

$$N_{jt} = \left(N_{j-1,t-1} + M_{j-1,t-1}\right) \phi_{j-1,t-1}$$

  where

  - N_{jt} denotes the numbers of individuals aged j in year t
  - $M_{j,t}$ is migration
  - $\phi_{j,t}$ are survival probabilities

- Total population is

$$N_t = \sum_j N_{jt}$$

- Population converges to a stat. distribution in the long run

Projected survival functions

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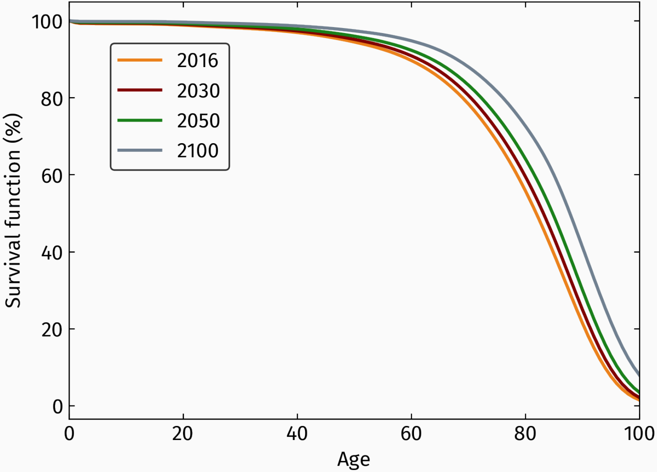
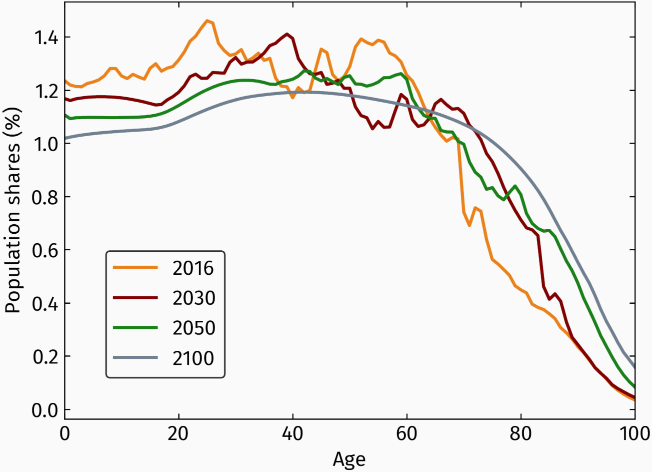
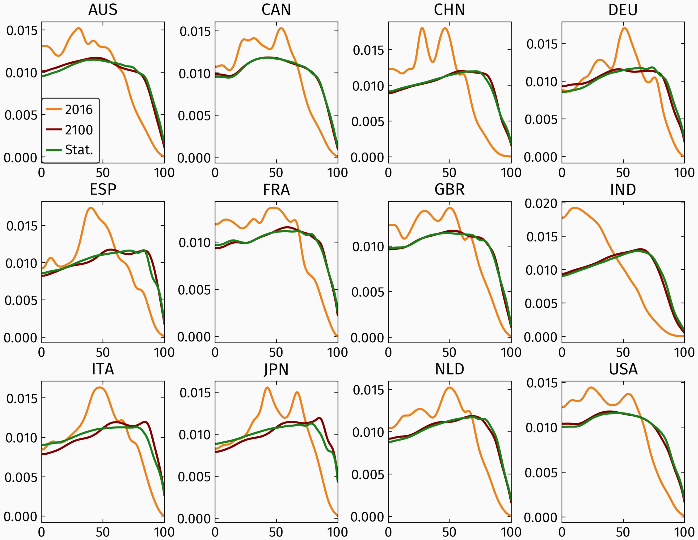


Projected population shares

Back

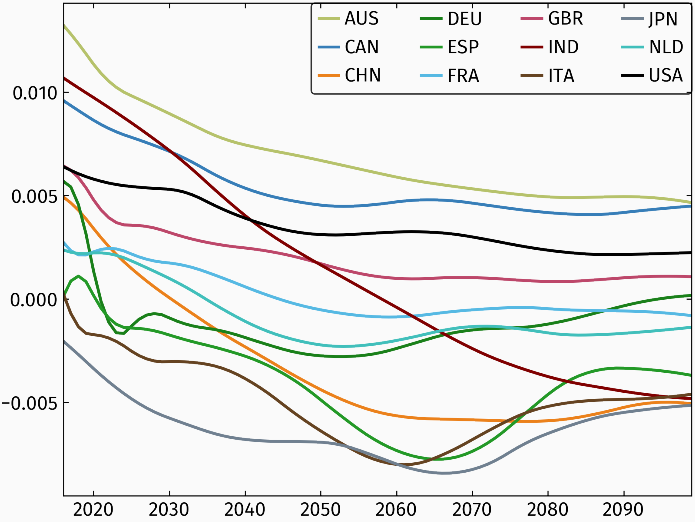


Demographics: population distributions



Demographics: population growth rates

Back



Semielasticities of asset supply and demand

- Assuming common capital-labor substitution elasticity η,

$$\bar{\epsilon}^s = \frac{\eta}{r_0 + \delta} \overline{\left(\frac{K_0}{W_0}\right)}$$

$\rightarrow$ Measurable from observables and knowledge of η

Proposition

With no idiosyncratic risk, $\underline{a} = \infty$, $\eta = 1$ *and* $r = \gamma = 0$*:*

$$\epsilon^d = \underbrace{\frac{1}{1+r}\frac{C}{W} \cdot \sigma \cdot Var\left(Age_c\right)}_{substitution\ \ effect} - \underbrace{\frac{1}{1+r}\left(E\left[Age_a\right] - E\left[Age_c\right]\right)}_{income\ \ effect}$$

$\rightarrow$ Measurable from observables and knowledge of σ

Implementation

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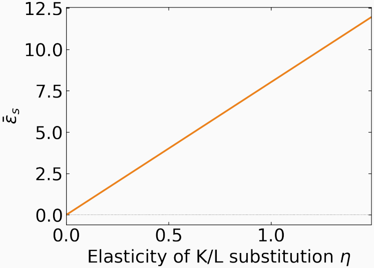
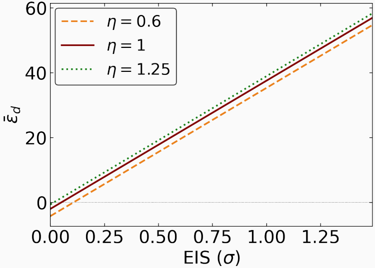
- Using formulas from the paper:





- Can compare $\overline{\epsilon_d}$ to literature estimates, range 2–40

  [Kleven-Schultz 2014, Zoutman 2018, Brulhart et al 2019, Jakobsen et al. 2020]

Updated environment

Household problem becomes

$$\max \mathbb{E}_k \sum_j \beta_j \Phi_{jk} \left[\frac{c_{jt}^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}} + \Upsilon Z_t^{\nu-\frac{1}{\sigma}} \left(1-\phi_{jt}\right) \frac{\left(a_{jt}\right)^{1-\nu}}{1-\nu} \right] \quad \nu \geq \frac{1}{\sigma}$$

$$\text{s.t.} \qquad c_{jt} + a_{j+1,t+1} \leq w_t \left((1-\tau_t)\ell_{jt}(z_j)(1-\rho_{jt}) + tr_{jt}(z_j)\right) + (1+r_t)a_{jt} + b^r_{jt}(z_j)$$

$$a_{j+1,t+1} \geq -\bar{a} Z_t$$

- From annuities to bequests:
    - assets become bequests at death, distributed as $b^r_{jt}(z_j)$
- Time-variation in mortality Φ_{jk}, labor supply ℓ_{jt}, ret. age ρ_{jt}
- Fiscal rule with adjustments in taxes and transfers, income process with intergenerational persistence
- Migration

Robustness of conclusions: steady-state

- Assume $\sigma = 0.5$, $\eta = 1$

	Δr	$\overline{\Delta \log \frac{W}{Y}}$	$\bar{\Delta}^{comp}$	$\bar{\Delta}^{soe}$	$\bar{\epsilon}^{d}$	$\bar{\epsilon}^{s}$
Sufficient statistic analysis	-1.23	9.9	31.8		17.8	8.0
Preferred model specification	-1.23	10.3	34.1	30.3	17.1	8.0
Alternative model specifications						
+ Constant bequests	-1.18	10.0	34.1	27.0	14.9	8.0
+ Constant mortality	-1.23	10.9	34.1	27.1	13.8	8.0
+ Constant taxes and transfers	-1.33	11.9	34.1	30.1	14.5	8.0
+ Constant retirement age	-1.49	13.4	34.1	34.1	14.6	8.0
+ No income risk	-1.47	13.2	33.9	33.9	13.8	8.0
+ Annuities	-1.33	11.5	34.2	34.2	17.2	8.0
Alternative fiscal rules						
Only lower expenditures	-1.29	11.0	34.1	32.6	17.9	8.0
Only higher taxes	-0.88	6.7	34.1	19.4	14.6	8.0
Only lower benefits	-1.50	12.9	34.1	39.1	18.4	8.0

- $\overline{\Delta}^{soe}$ is response of W/Y to demographics at fixed r

Robustness of conclusions: transitions

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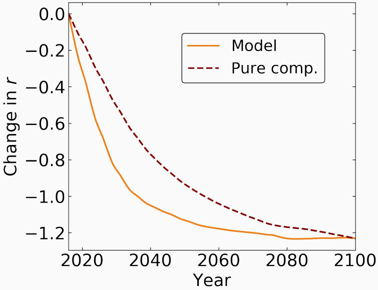
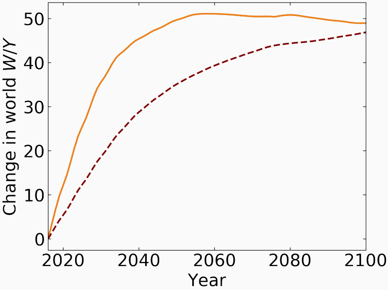
A. Change in r



B. Change in world W/Y



World economy calibration

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	$\Delta_{comp,c}$		Components of wealth			Government policy	
Country	Model	Data	$\frac{W^c}{Y^c}$	$\frac{B^c}{Y^c}$	$\frac{NFA^c}{Y^c}$	τ^c	$\frac{Ben^c}{Y^c}$
AUS	30	29	5.09	0.40	-0.46	0.29	0.04
CAN	21	20	4.63	0.92	0.20	0.31	0.04
CHN	47	45	4.20	0.44	0.25	0.30	0.04
DEU	21	20	3.64	0.69	0.58	0.50	0.10
ESP	42	37	5.33	0.99	-0.74	0.39	0.10
FRA	31	30	4.85	0.98	-0.05	0.48	0.13
GBR	27	26	5.35	0.88	0.08	0.31	0.06
IND	65	56	4.16	0.68	-0.08	0.30	0.01
ITA	34	30	5.83	1.31	-0.02	0.48	0.13
JPN	24	22	4.85	2.36	0.66	0.32	0.09
NLD	34	33	3.92	0.62	0.70	0.37	0.05
USA	32	29	4.38	1.07	-0.36	0.32	0.06

World economy calibration

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