Demographics and the U.S. Economy

Jorge Barro

March 21, 2023

Overview

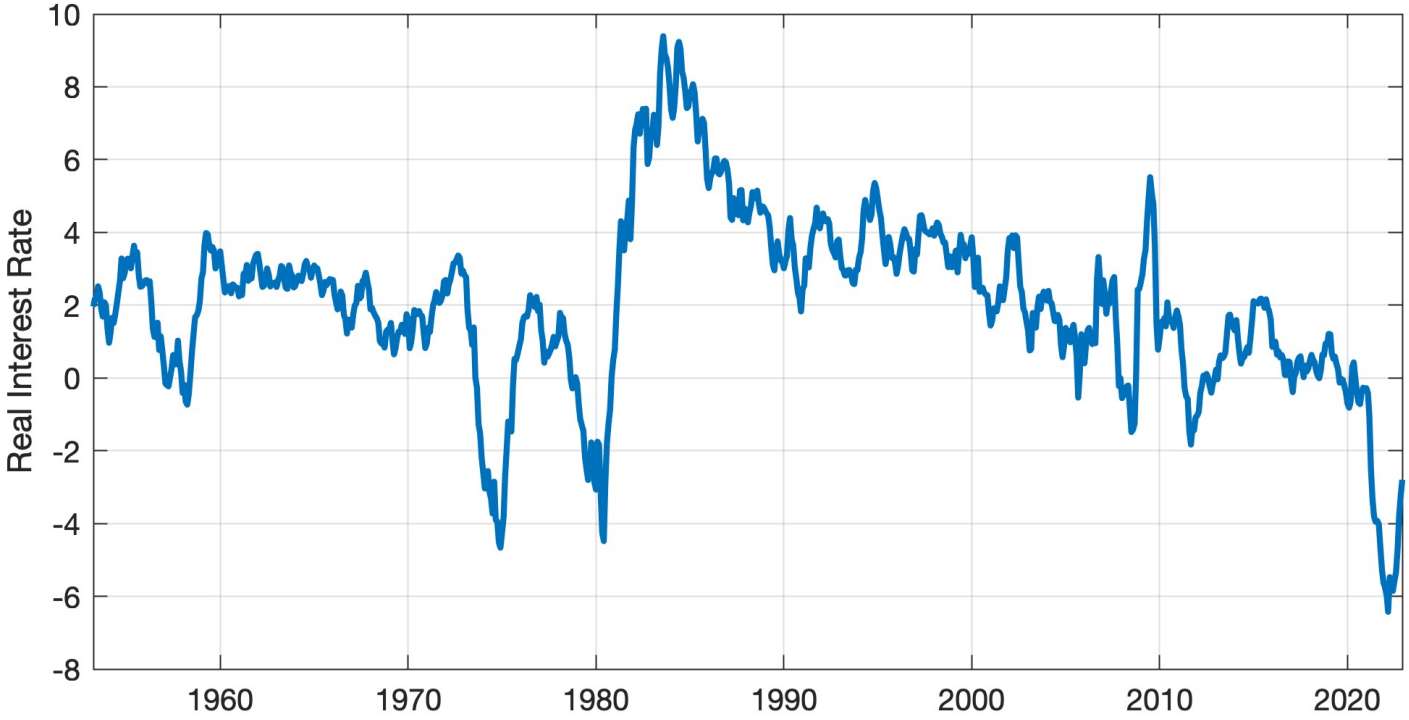
- Trends in the U.S. economy over several decades:
  - Slowdown in economic growth.
  - Capital expansion (relative to GDP).
  - Decline in interest rates.

Overview

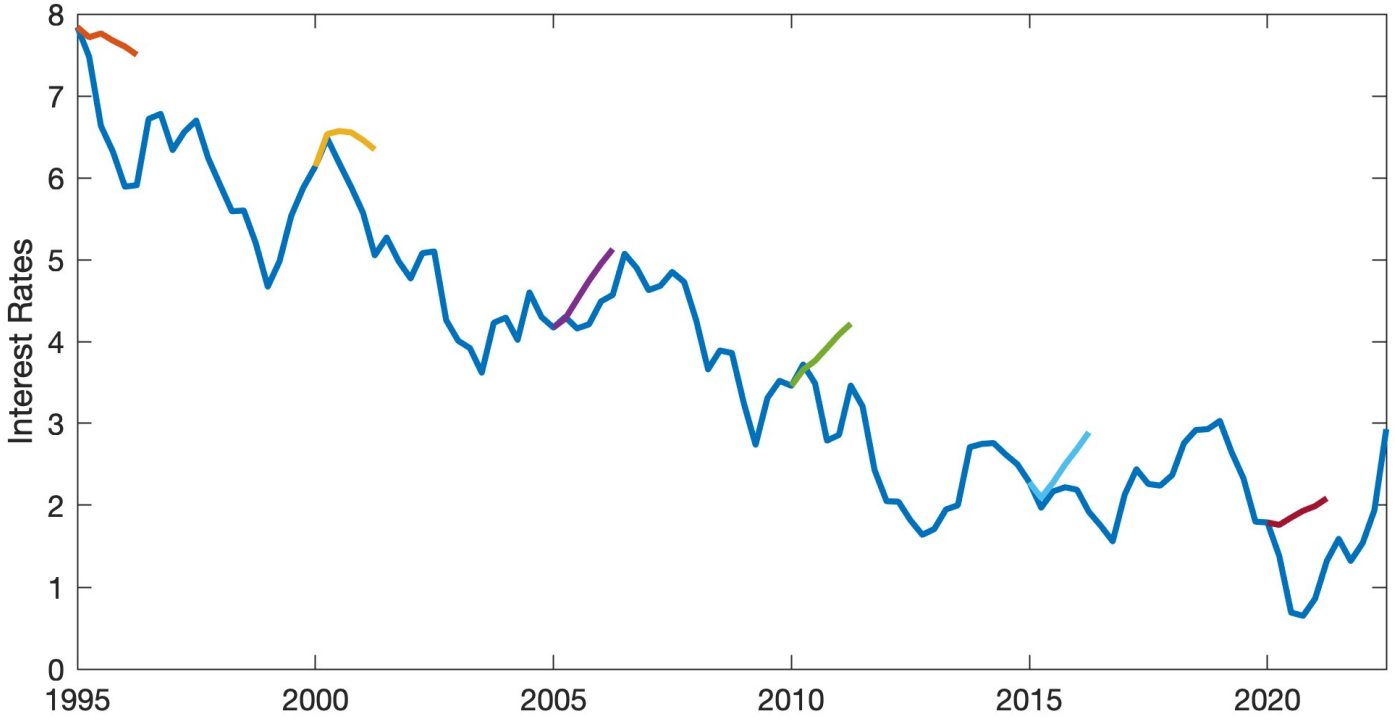
- Q: How much can demographics (aging) explain macro trends?
- Focus on outputs of standard neo-classical growth model, capital markets.
- Implications for government debt, institutions, and the macro outlook.

Motivation: Historical Nominal Interest Rate

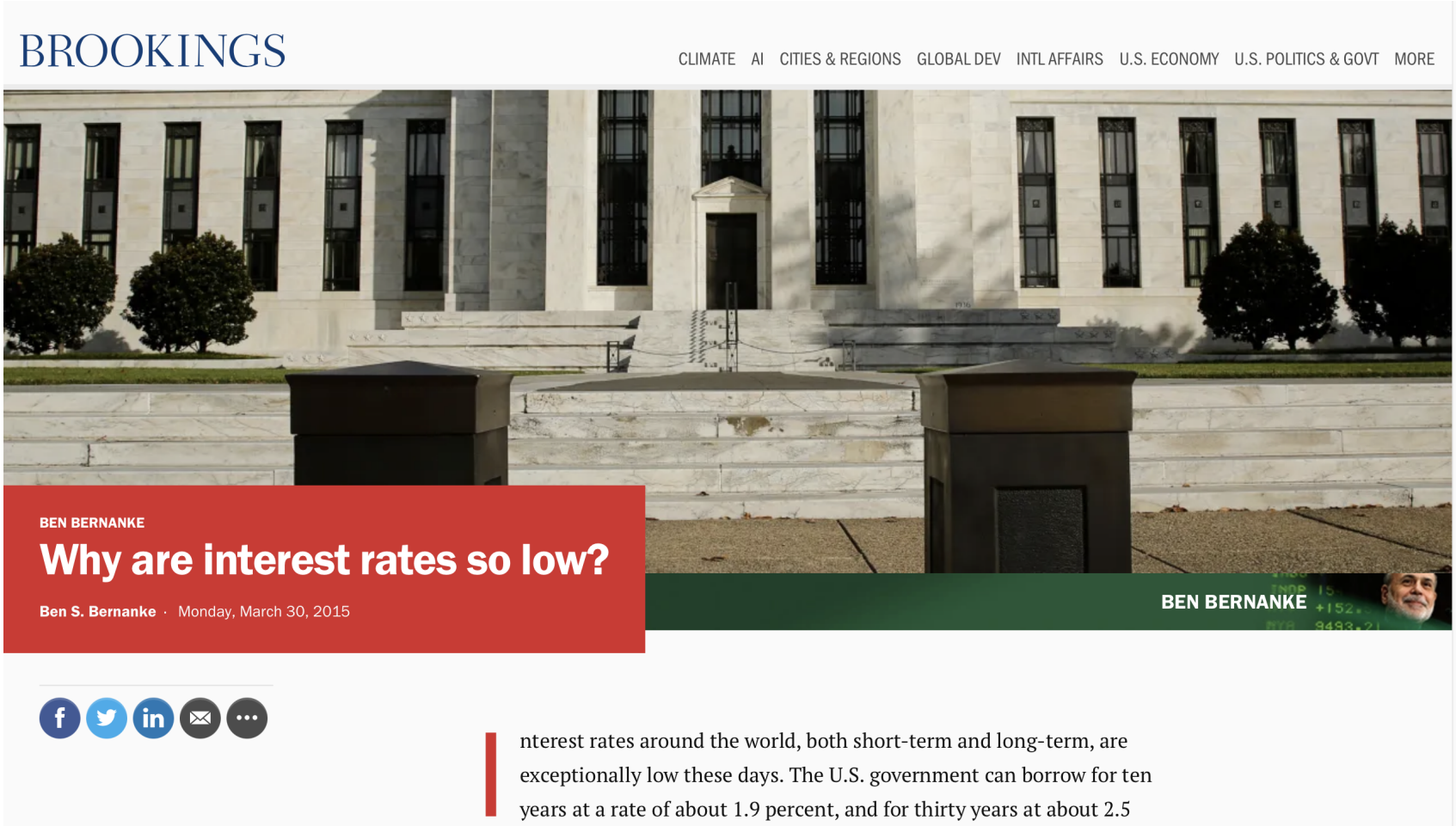
Motivation: Historical Real Interest Rate



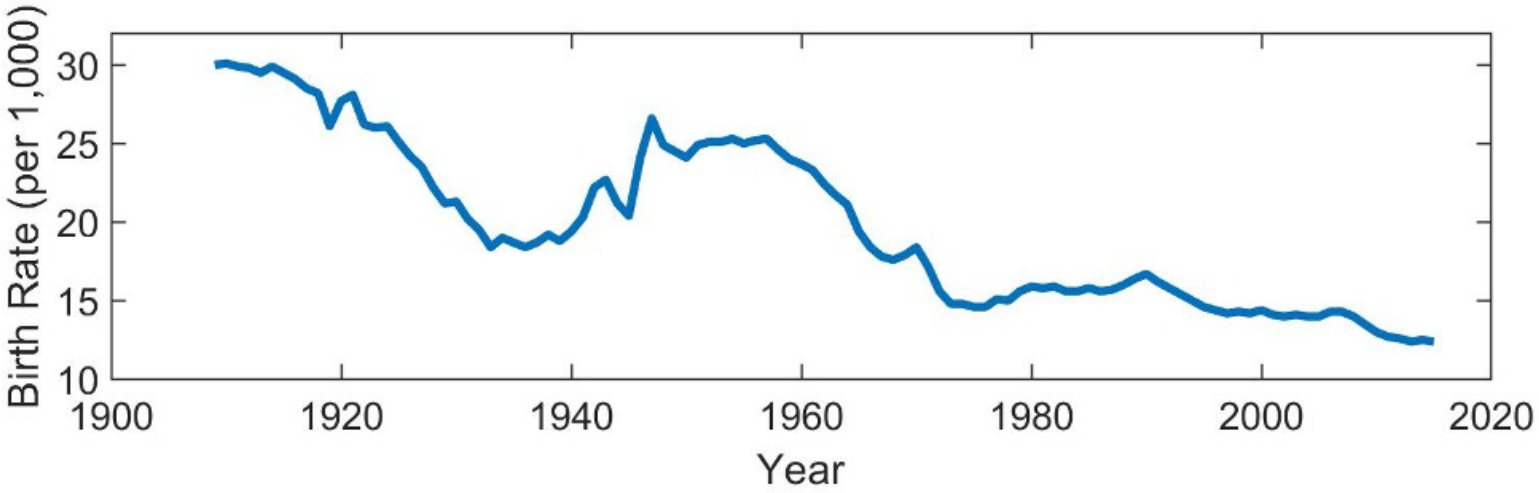
Historical Interest Rate Forecasts

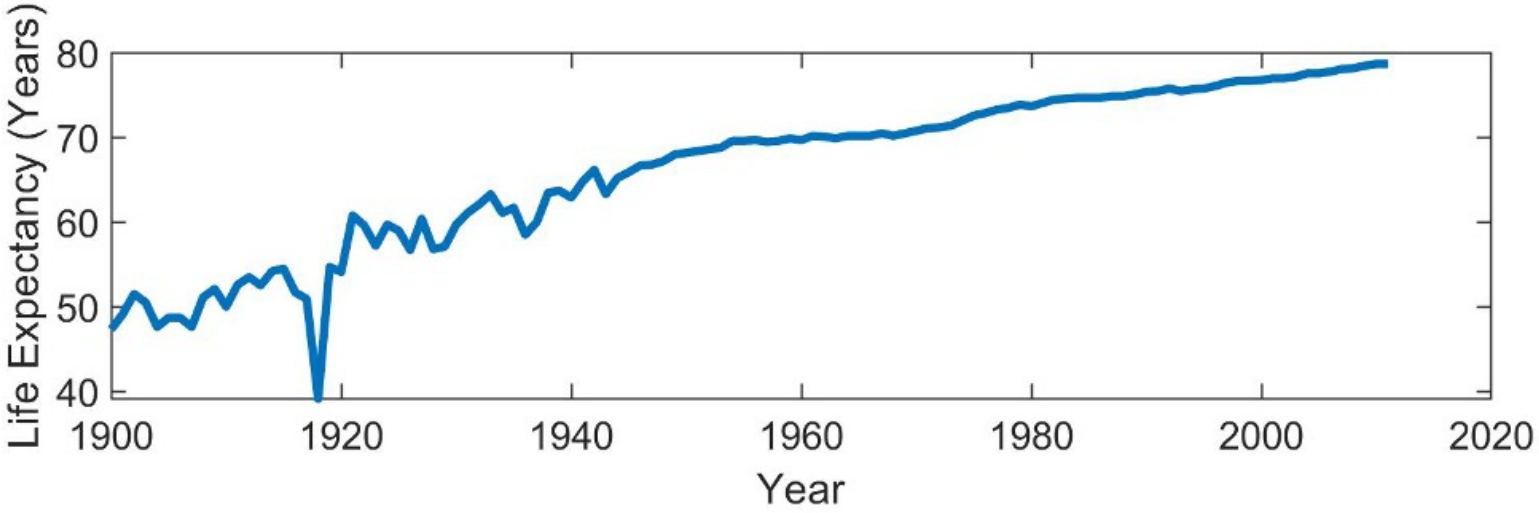


Bernanke: "Why are interest rates so low?"

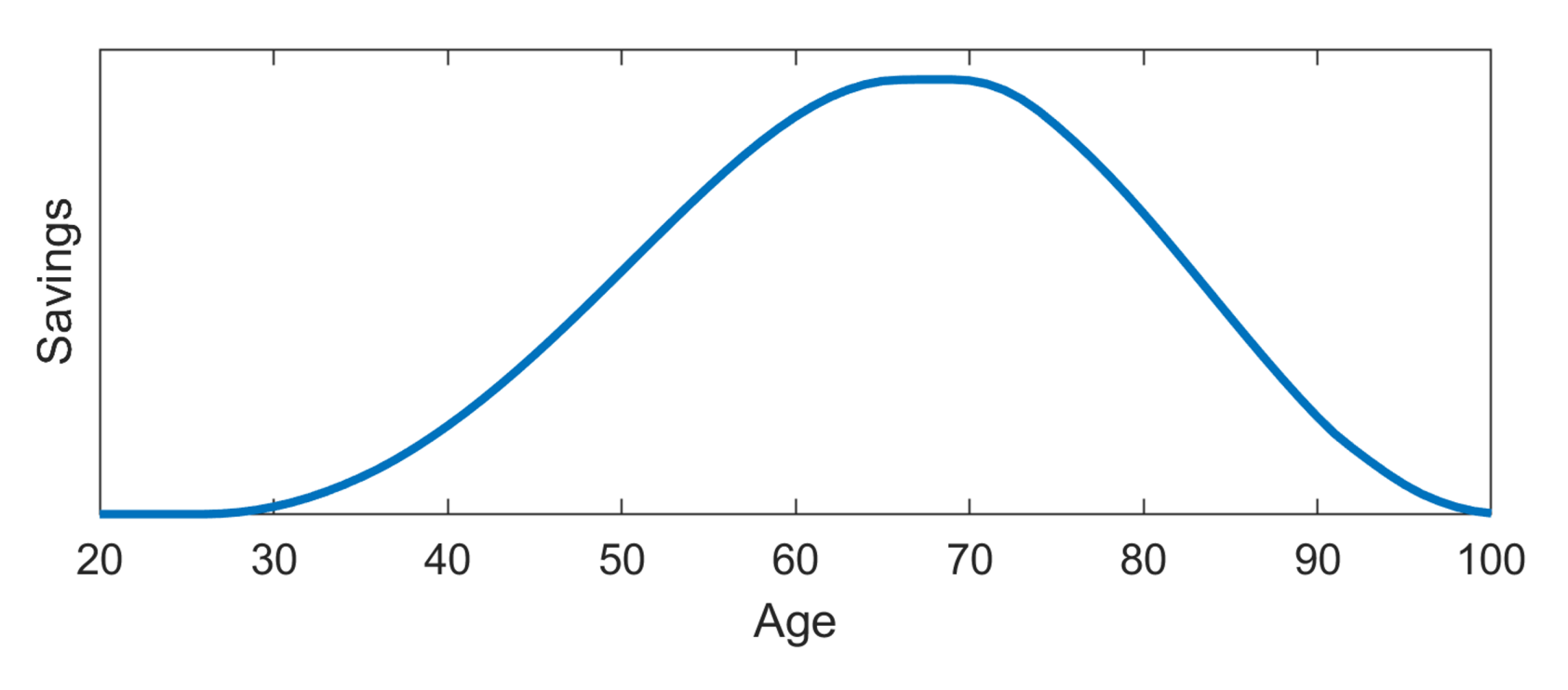


The Demographics Hypothesis





Lifecycle Saving



Literature Overview

- Secular Stagnation: Summers (2014), Eichengreen (2014), Gordon (2014).

- Demographics and interest rates: Carvalho, Ferrero, and Nechio (2016); Gagnon, Johannsen, and Lopez-Salido (2016).

Model Overview

- Heterogeneous-agent, overlapping generations neo-classical growth model.
- Features: immigration, education, taxation, labor productivity growth (exogenous).
- Closed economy of U.S., but results generalize to world economy.

Labor Productivity Process

- Lifecycle component, common among all individuals.
- Education is an age- and time- independent labor productivity premium.
- Uninsurable labor productivity shock ε drawn from discrete distribution: $\varepsilon \in \{\varepsilon_1, \ldots, \varepsilon_N\}$.
- Initial shock (at initial working age) drawn from $\mathcal{N}\left(0, \sigma^2_{initial}\right)$.
- Subsequent draws follow age- and time-independent Markov process.
- Two high shocks to match income and wealth distributions.

Individual Bellman Equation

Cohort-j individual takes prices $\{w_t, r_t\}$ and policy as given and solves:

$$V^e_{j,t}(a^e_{j,t}, \varepsilon) = \max_{c^e_{j,t}, n^e_{j,t}, a^e_{j,t+1}} \frac{\left({c^e_{j,t}}^{\gamma}(1-n^e_{j,t})^{1-\gamma}\right)^{1-\sigma}}{1-\sigma} + s_{j,t}\beta E_{\varepsilon'|\varepsilon} V^e_{j,t+1}(a^e_{j,t+1}, \varepsilon') \tag{1}$$

$$\text{s.t.} \quad c^e_{j,t} = w_t \varepsilon \epsilon^e_t z_{t-j+1} n^e_{j,t} + (1+r_t)a^e_{j,t} - a^e_{j,t+1} - \phi_e(\cdot), \tag{2}$$

$$\text{and} \quad \phi_e(\cdot) = \tau_e \left(w_t \epsilon^e_t z_{t-j+1} n^e_{j,t} + r_t a^e_{j,t}\right), \tag{3}$$

Demographic Dynamics

- Natives:

$$\mu^e_{j,t+1} = s_{j,t}\mu^e_{j,t} \tag{4}$$

- Immigrants:

$$\tilde{\mu}^e_{j,t+1} = s_{j,t}\tilde{\mu}^e_{j,t} + m^e_{j,t+1} \tag{5}$$

- Population:

$$M_t = \sum_{j=t}^{t-J+1} \sum_{e\in\{h,l\}} \left(\mu^e_{j,t} + \tilde{\mu}^e_{j,t}\right). \tag{6}$$

Demographic Inflows

- Birth rate:

$$\sum_{e \in \{h,l\}} \mu^e_{t+1,t+1} = \zeta_t M_t. \tag{7}$$

- Native education rate determination:

$$\mu^e_{t+1,t+1} = \zeta_t \lambda^e_t M_t. \tag{8}$$

- Net immigration rate by education:

$$m^e_{j,t+1} = \psi_t \tilde{\lambda}^e_{j,t} M_t. \tag{9}$$

Simulating Demographics

- Because of forward-looking agents, need initial stability in model.
- Given initial survival, immigration, birth, and education rates, find a stationary relative distribution.
- As data becomes available, integrate dynamics.
- Use projections and extrapolations for long-term forecasting.

Firms

- Take prices as given and solve:

$$\max_{K_t, L_t} K_t^{\alpha} (A_t L_t)^{1-\alpha} - (r_t + \delta) K_t - w_t L_t, \tag{10}$$

- Resulting conditions:

$$r_t = \alpha \left(\frac{K_t}{A_t L_t} \right)^{\alpha - 1} - \delta \tag{11}$$

$$w_t = (1 - \alpha) \left(\frac{K_t}{A_t L_t} \right)^{\alpha}. \tag{12}$$

Government

- Finances exogenous stream of expenditures (no real value).
- Distributes unintended bequests evenly.

Equilibrium

A dynamic general equilibrium is defined as a set of prices and values such that:

1. Given prices and policy, individuals optimize.
2. Firms optimize in competitive markets.
3. Markets clear.
4. Government budget constraint is satisfied.
5. Accidental bequests are divided evenly among all surviving agents.

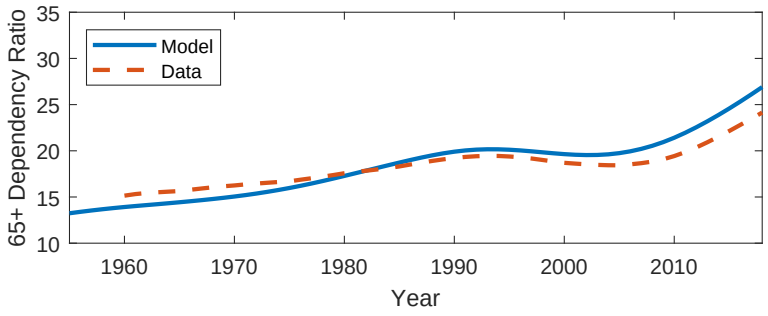
Parameterization: Deep Parameters

Parameter	Symbol	Value
Coefficient of Relative Risk Aversion	σ	3
Consumption Share of Utility	γ	0.35
Discount Factor	β	1.025
Maximum Age	J	120
Capital Share	α	0.36
Depreciation Rate	δ	0.085
Labor Productivity Growth Rate	g	0.0125
High Marginal Tax Rate	τ_h	0.1208 (CPS)
Low Marginal Tax Rate	τ_l	0.0615 (CPS)

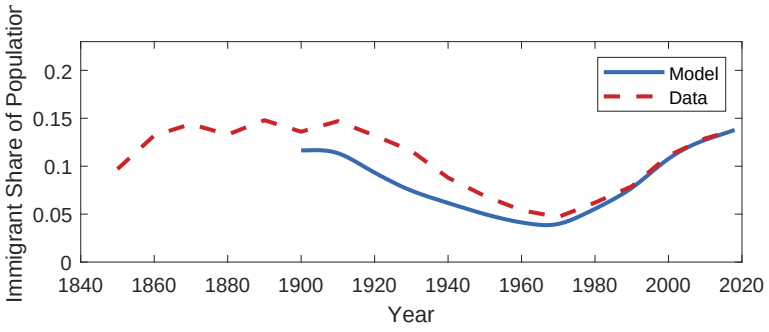
Parameterization: Demographics

- Birth rates: National Center for Health Statistics (historical, starting in 1909), U.S. Census Bureau (projections to 2060), linear extrapolation 2060-2095.
- Survival probabilities: Social Security Administration (historical and projected to 2095), held constant past 2095. Smoothed with H-P filter.
- Education types: Estimated college attainment rate, ACS 1940-2019. Linearly extrapolated for 10 years, constant thereafter.
- Immigration: net rates from Migration Policy Institute; age and education distributions estimated from ACS data. Immigration projections provided by U.S. Census Bureau.

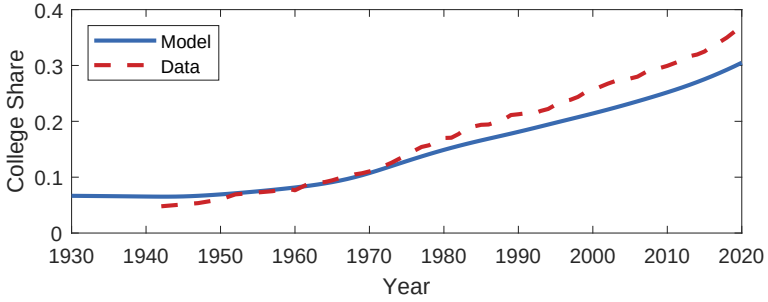
Model Validation: Demographics



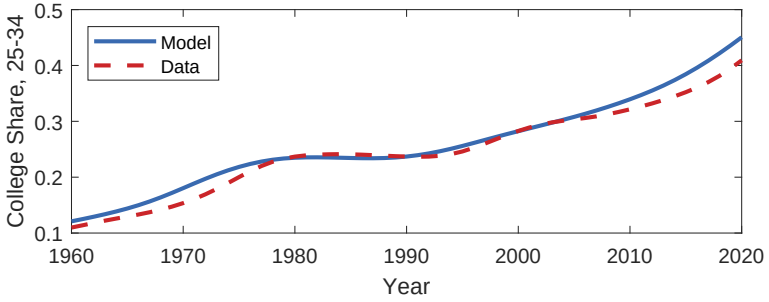
(a) 65+ to 15-64 population ratio.



(b) Immigrant share of population



(c) College attainment share of population



(d) College attainment share of 25-34 population

Figure: Baseline demographics, model vs. data

Model Validation: GDP Growth

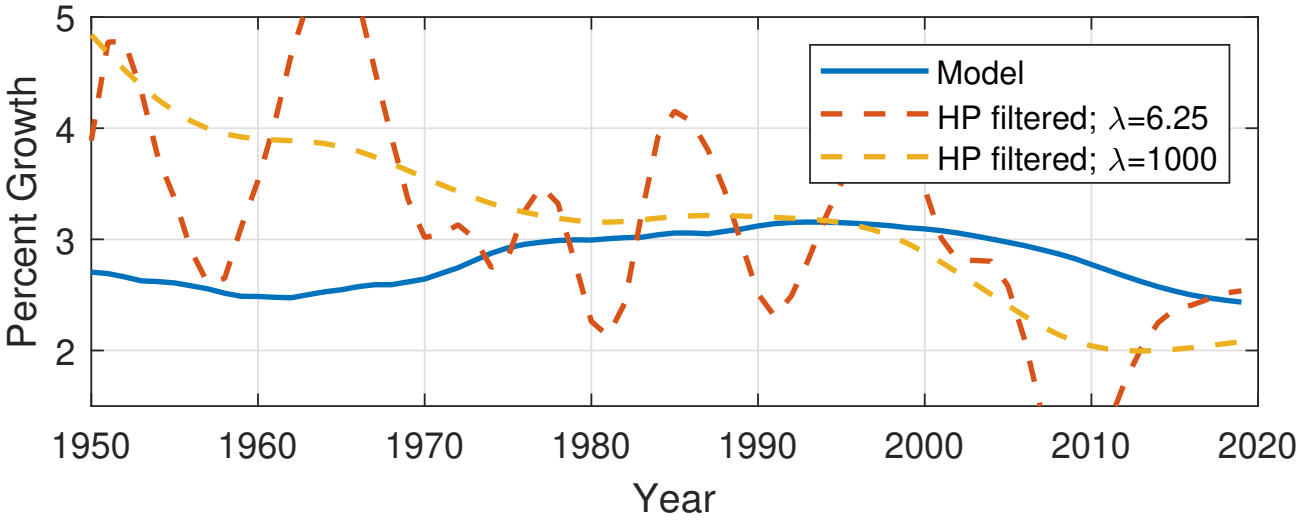


Figure: GDP Growth

Mechanism: GDP Growth

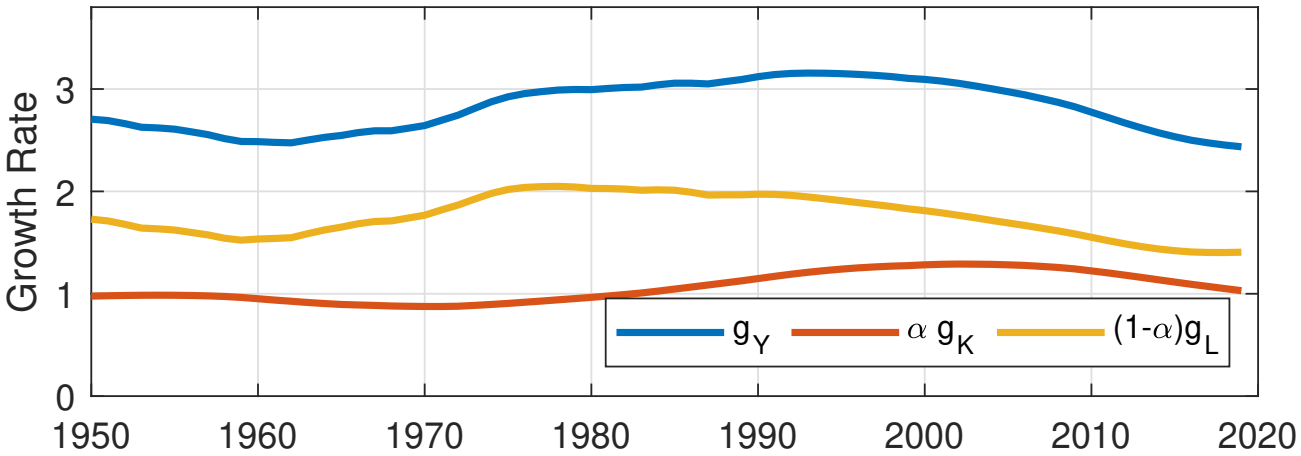


Figure: Composition of Growth Rate

Model Validation: Capital to Output

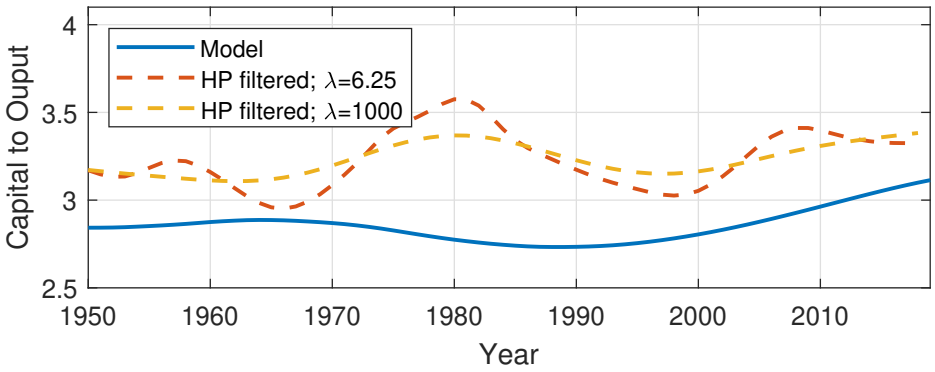


Figure: Capital to Output

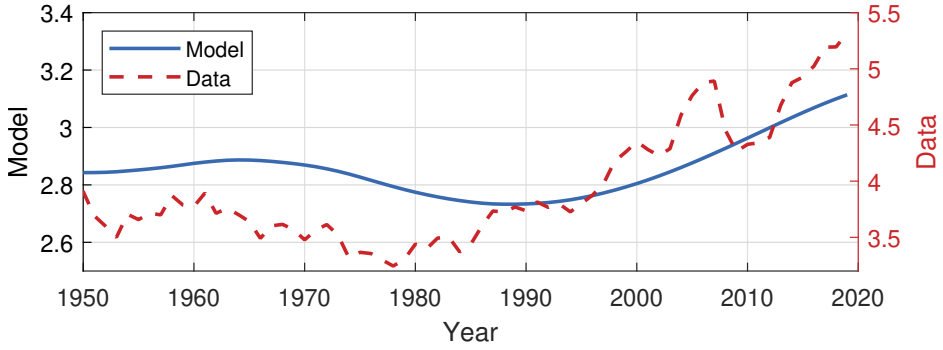


Figure: Net Worth to Output

Model Validation: Interest Rate

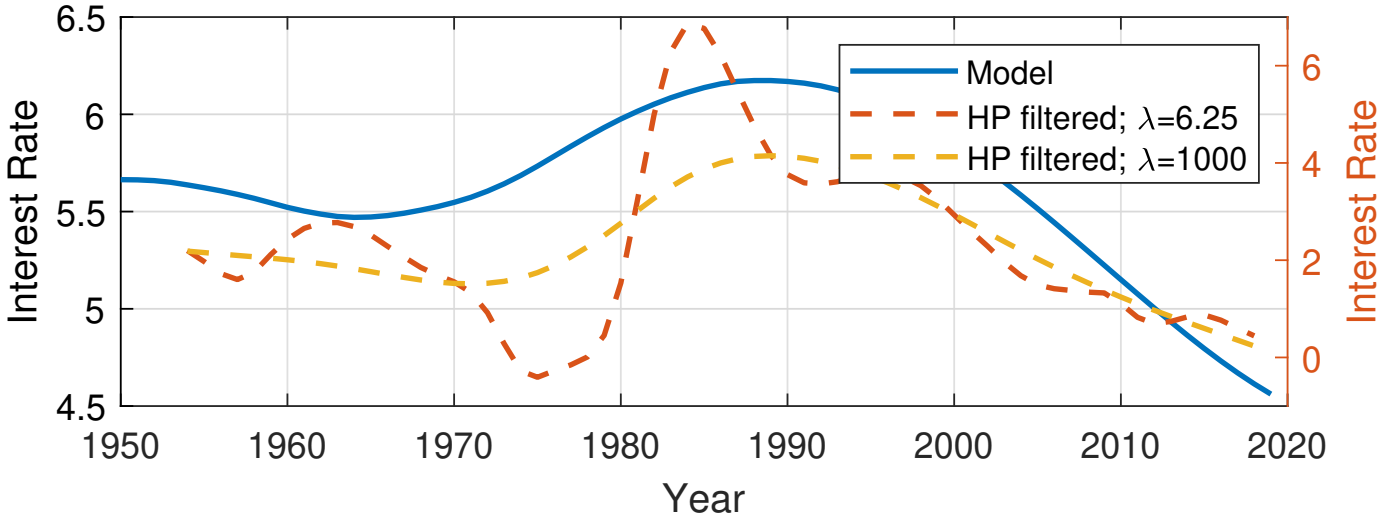


Figure: Interest Rate

Projections: GDP Growth

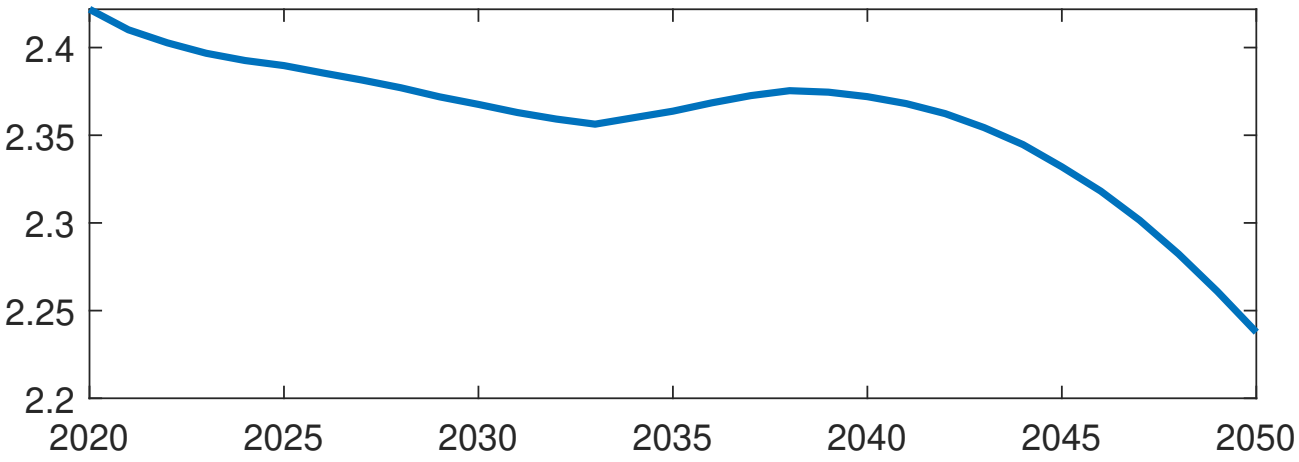


Figure: GDP Growth Rate

Projections: Capital to Output

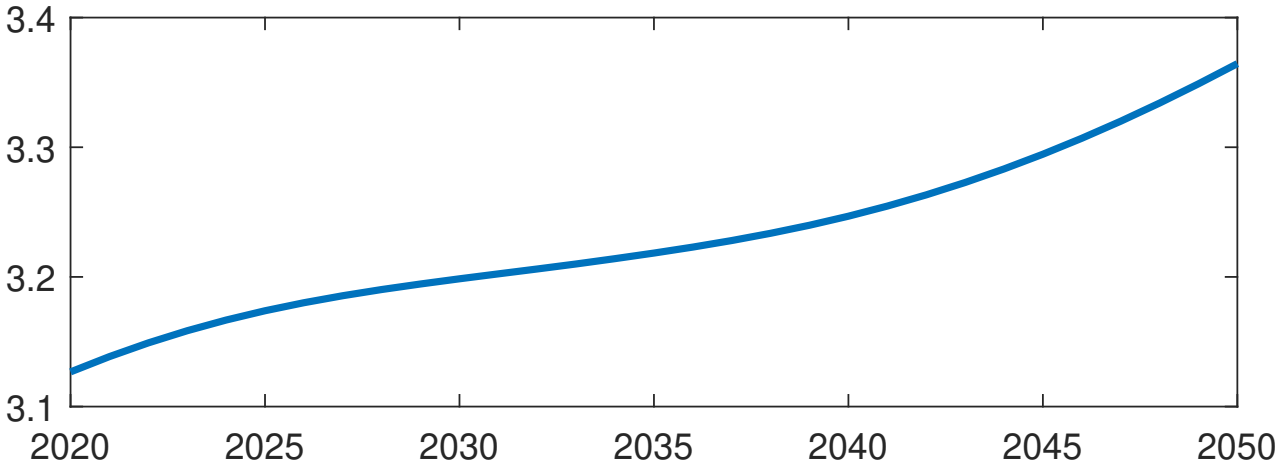


Figure: Capital to Output

Projections: Interest Rate

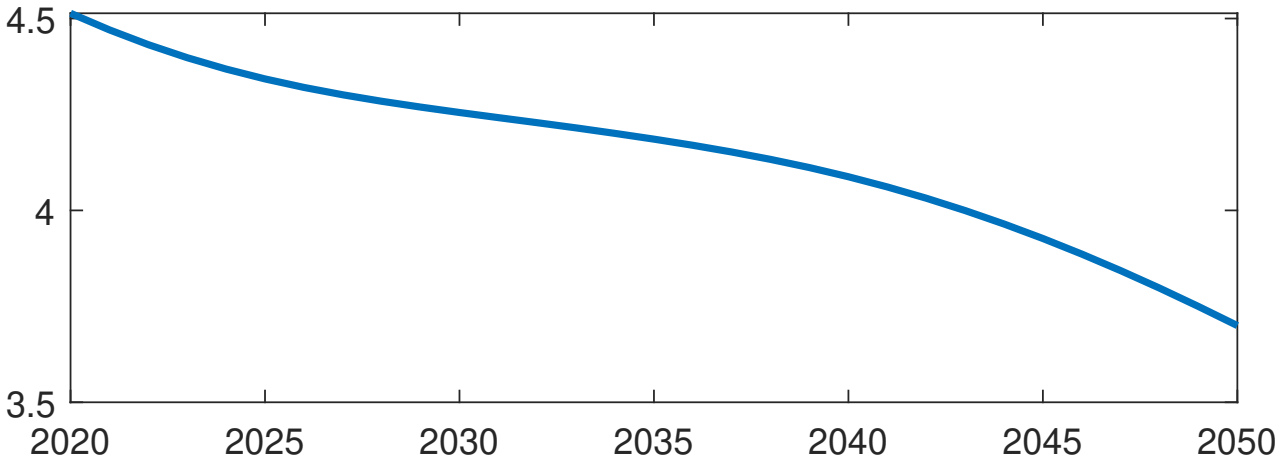


Figure: Interest Rate

Other Model Findings

- Without higher education, GDP would be 18% lower.
- Demographics can not explain trends in income and wealth inequality.
- Without immigration since 1850, U.S. economy would be 20% of its current size.
- Very little that reasonable immigration policy can do to offset age demographics.

Role of Demographics: Other Areas

- Inflation: Juselius and Takas (2021).
- Industry dynamics: Hopenhayn, Niera, and Singhania (2022).
- Business cycles?

Expansion Durations

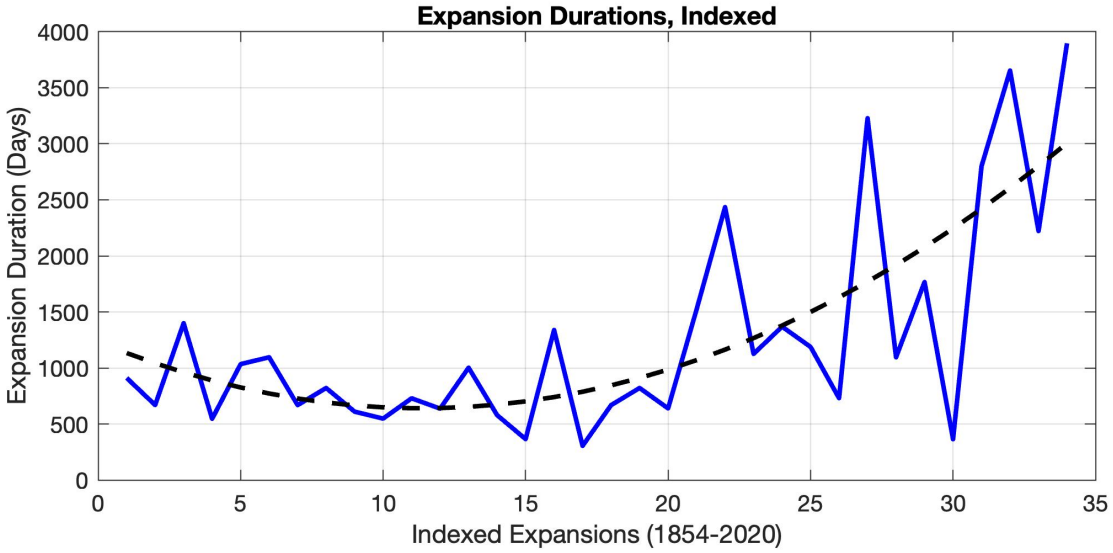


Figure: Indexed expansion durations. Index=20 is the Great Depression.

Implications of Findings

- Growing share of capital income $\rightarrow$ importance of financial market stability.
- Capital expansion likely dampened the effects of government debt growth.
- May need to rely more on capital income taxation to stabilize the budget.
- Current increase in interest rate more likely cyclical than change in trend.

Conclusion

- Demographics plays important role throughout all of macroeconomics.
- Likely accounts for interest rate trends.
- More more research to be done.