Demographic Trends and the Real Interest Rate

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Bank of England

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Key points

- Unprecedented **rise in life expectancy** in recent decades in advanced economies
- Understand the **macroeconomic impact** of this change in the composition of the population
- A key implication: fall in the **neutral interest rate**

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- OLG model to **quantify** the effect of population ageing
- Across all advanced-countries, **ageing can explain**:
  - About 160bp of fall in **interest rates** since 1980, with a further 40bp still to come
  - More than 75% of the rise in **house prices** and **private credit** to GDP
  - Some of the **labour productivity** slow down since the 2000s
  - Just under 30% of the variation in **net foreign asset positions**

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  - Some of the **labour productivity** slow down since the 2000s
  - Just under 30% of the variation in **net foreign asset positions**
- Without a reversal of life expectancy, these effects will be **permanent**

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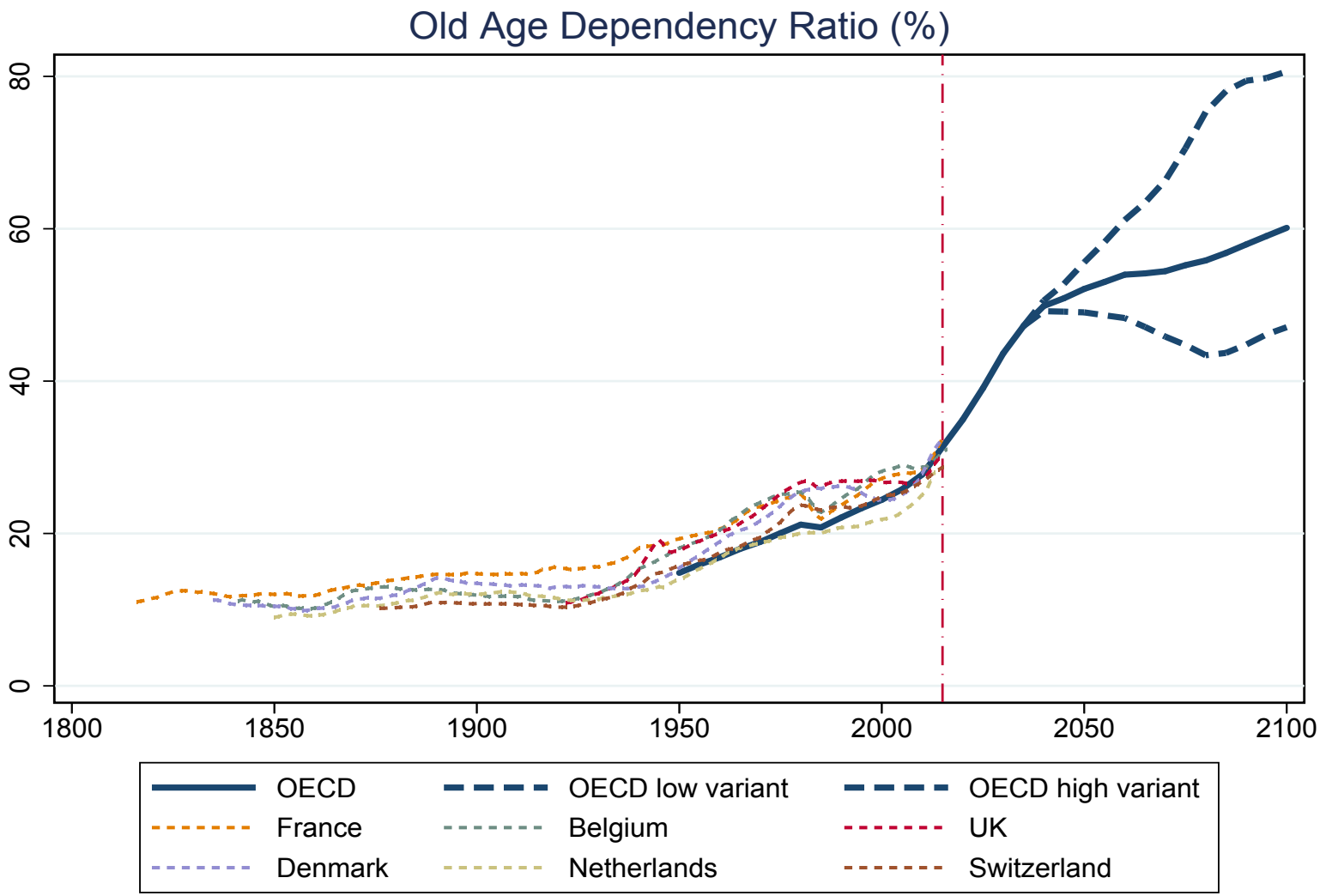
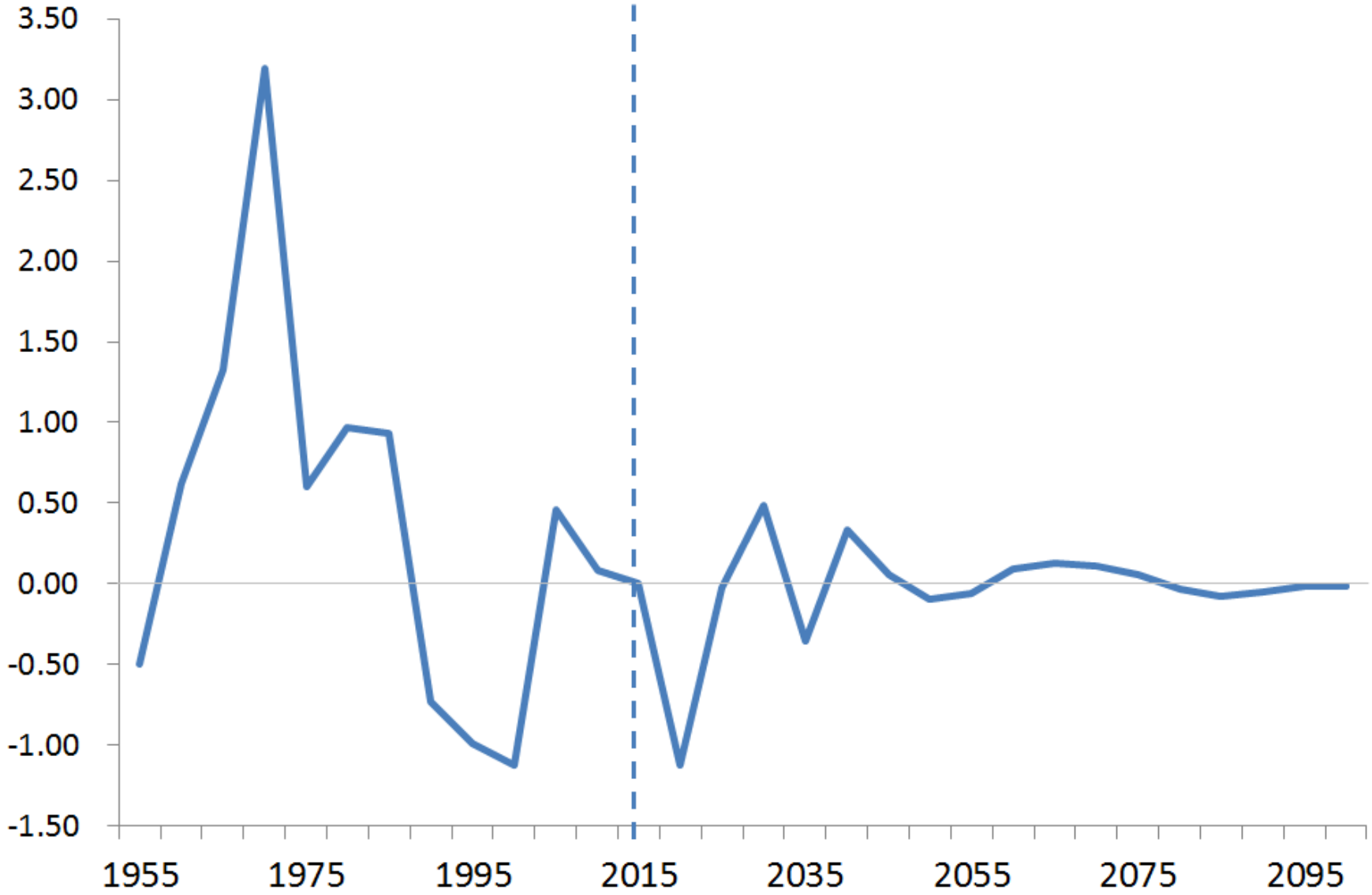
Unprecedented population ageing



Source: UN Population Statistics, Human Mortality Database

Population growth

Growth rate of 20-24 year old cohort



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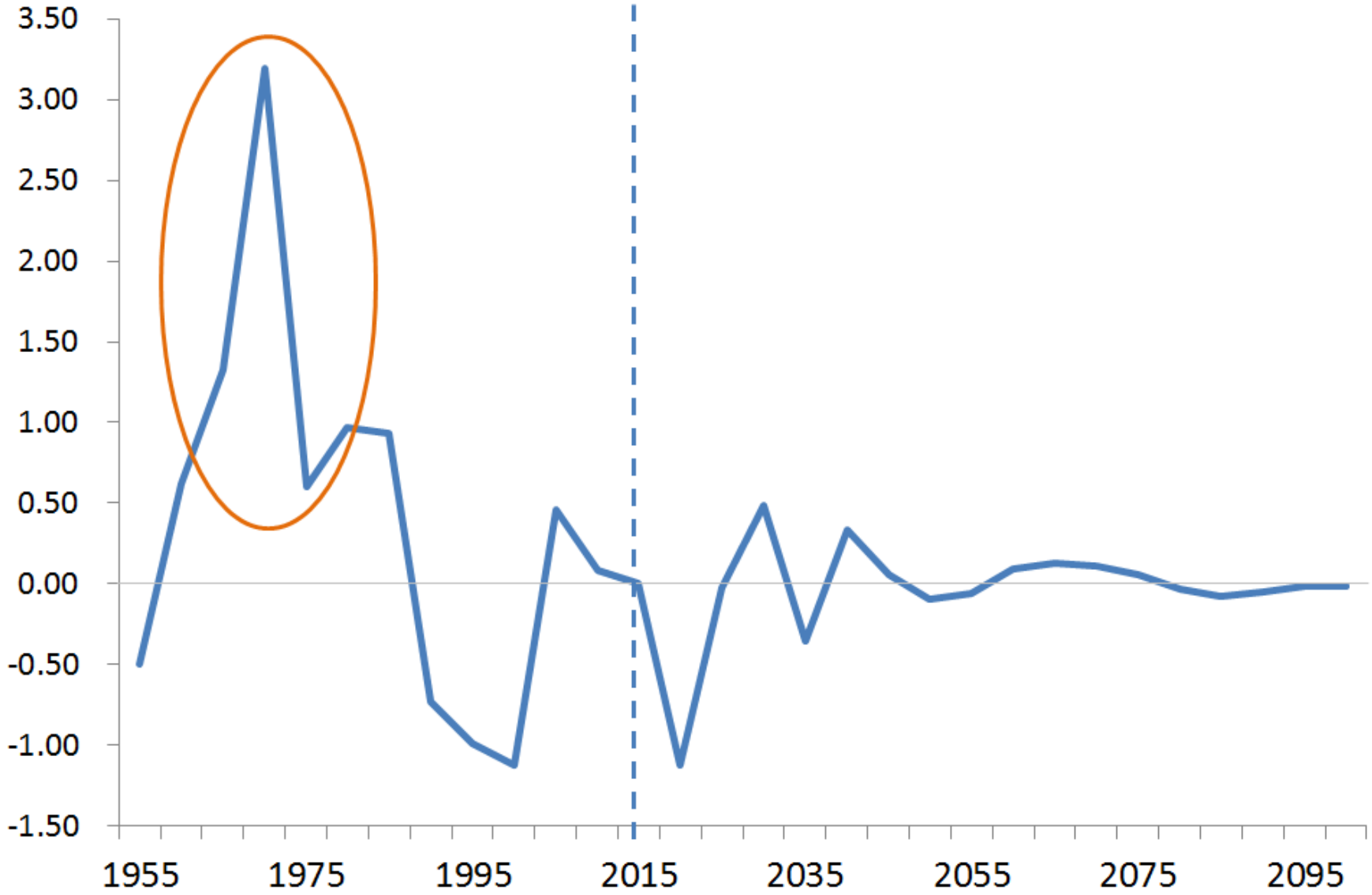
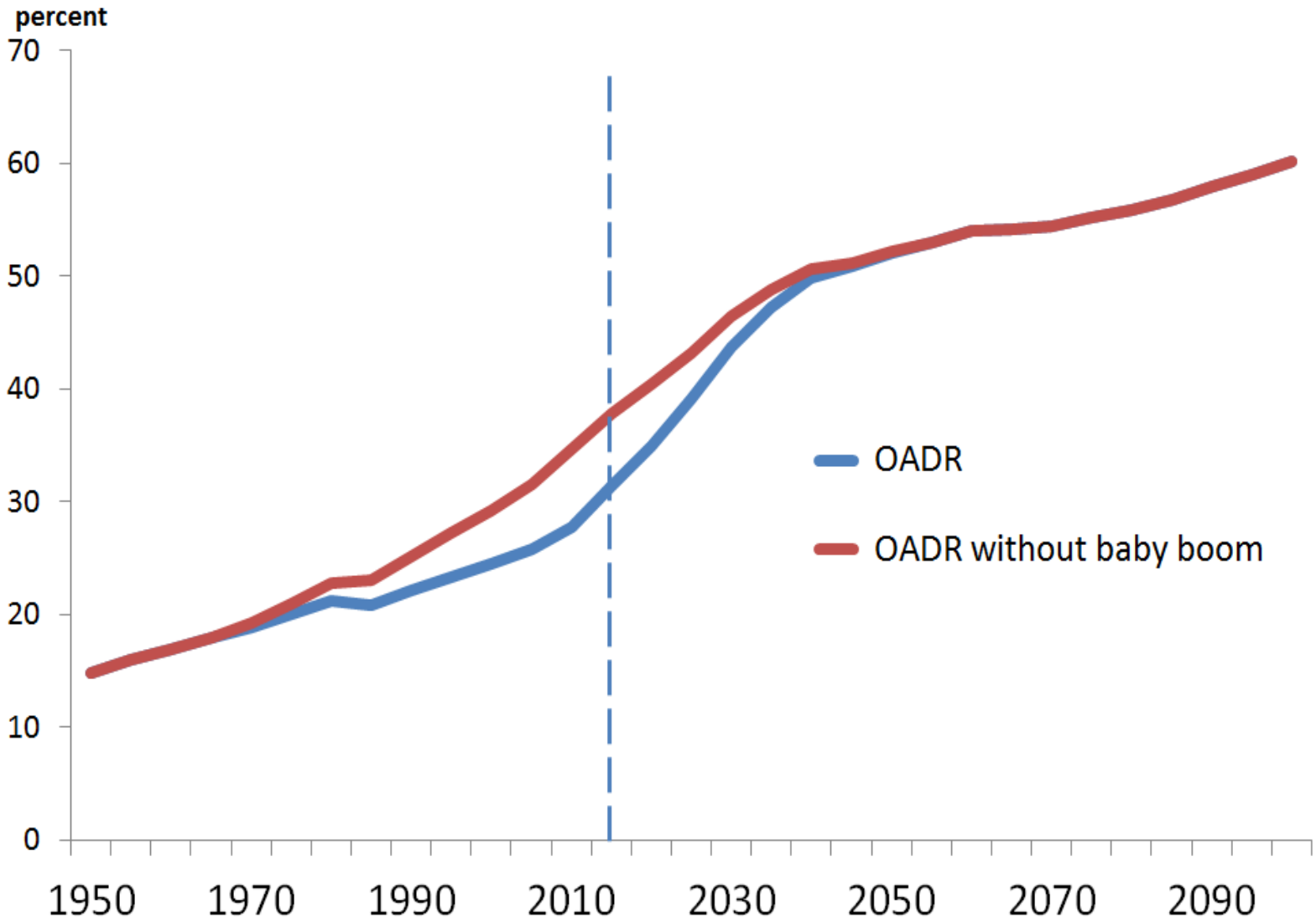
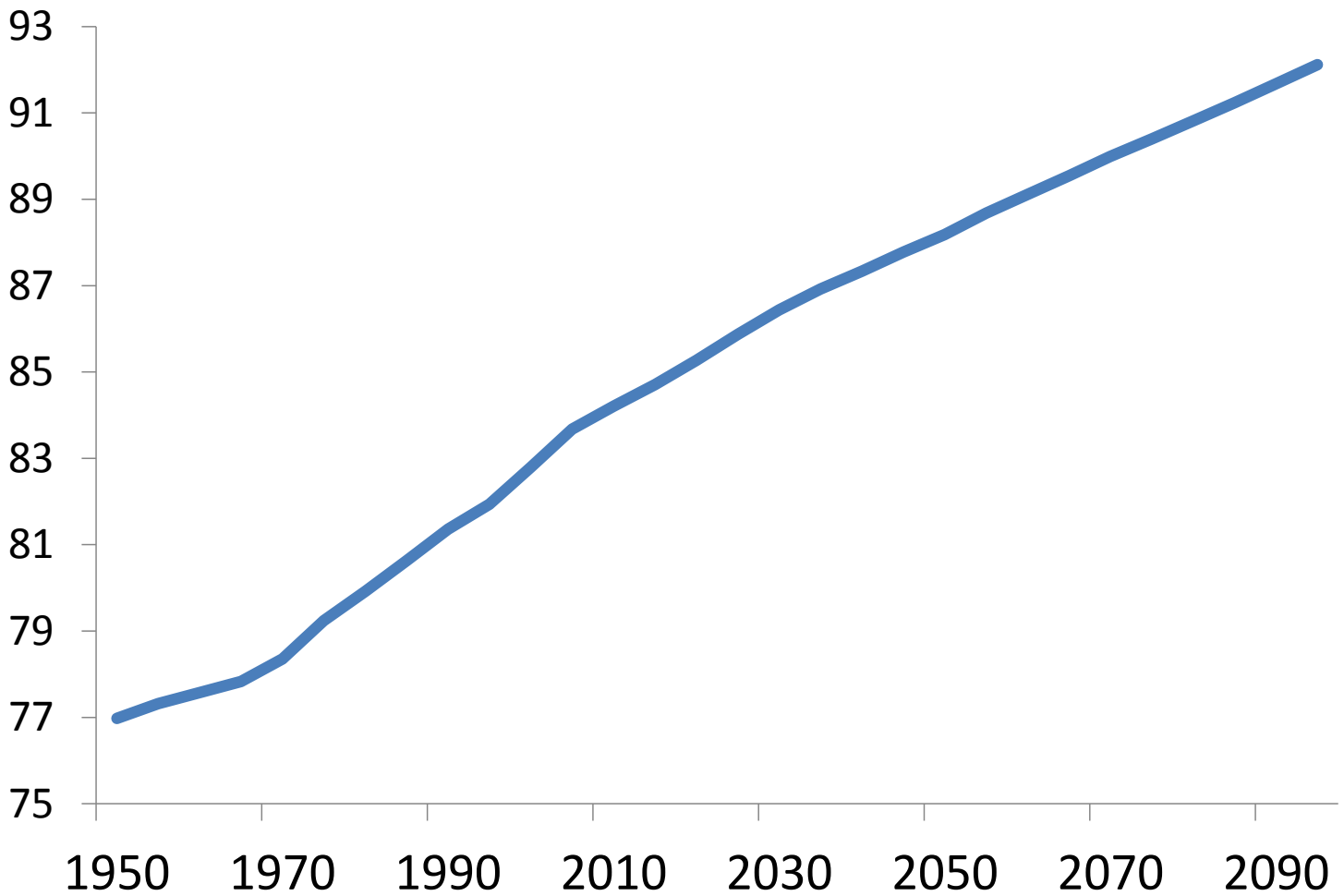


Baby boomers are not the main factor



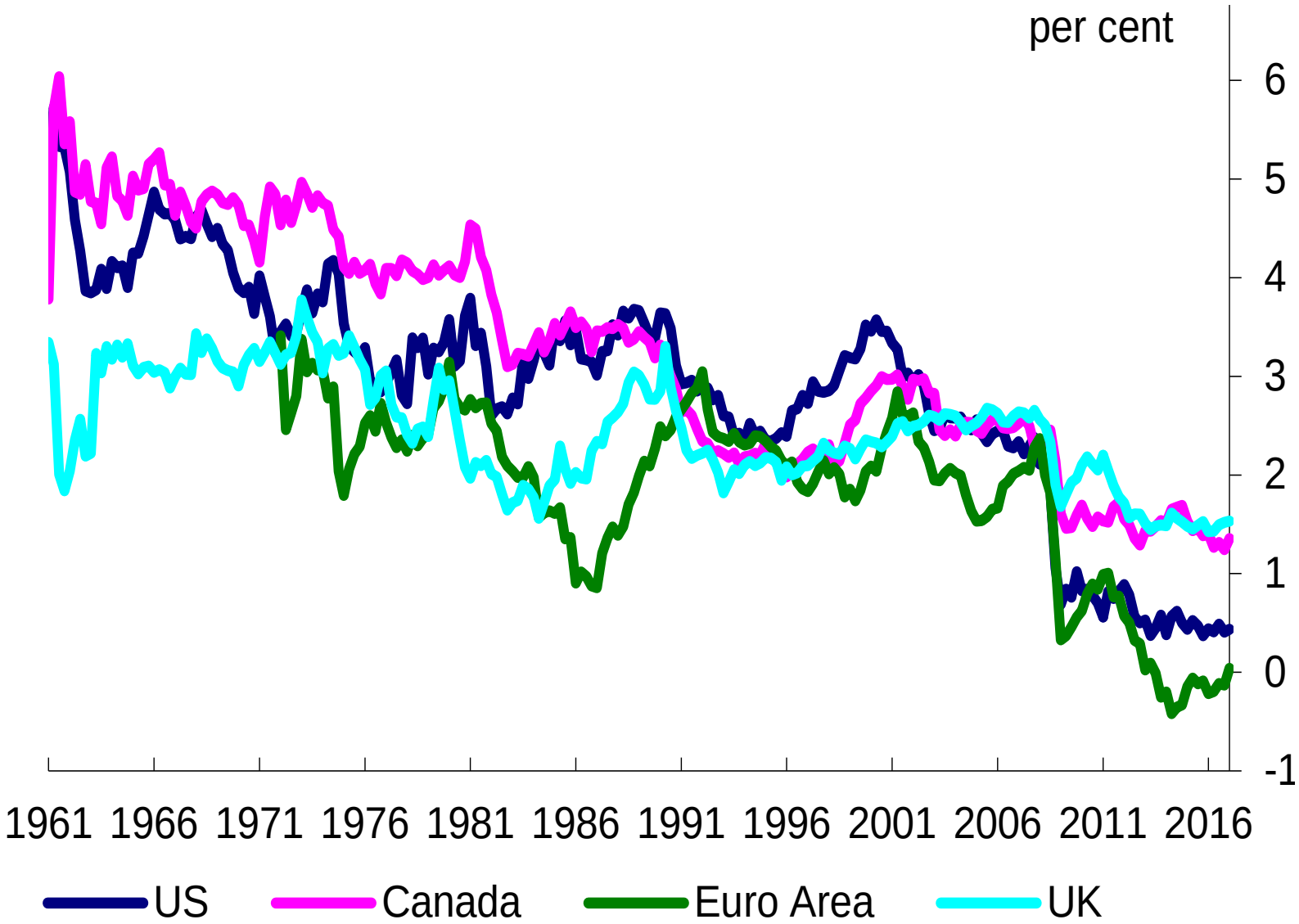
Source: UN Population Statistics, own calculations

Life expectancy at 60



Source: UN Population Statistics

Natural interest rate in advanced economies since 1960



Source: Holston, Laubach and Williams (2017)

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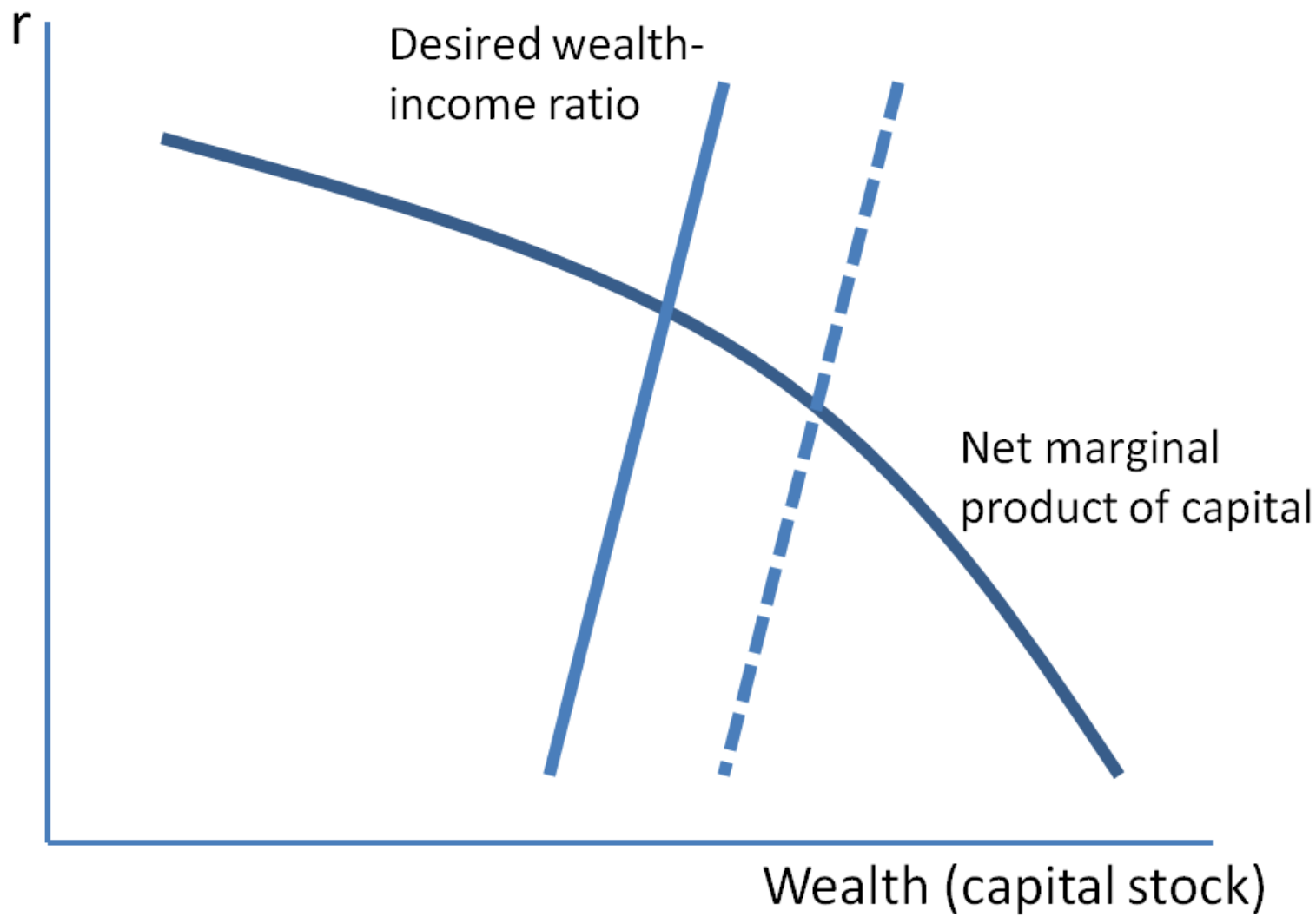
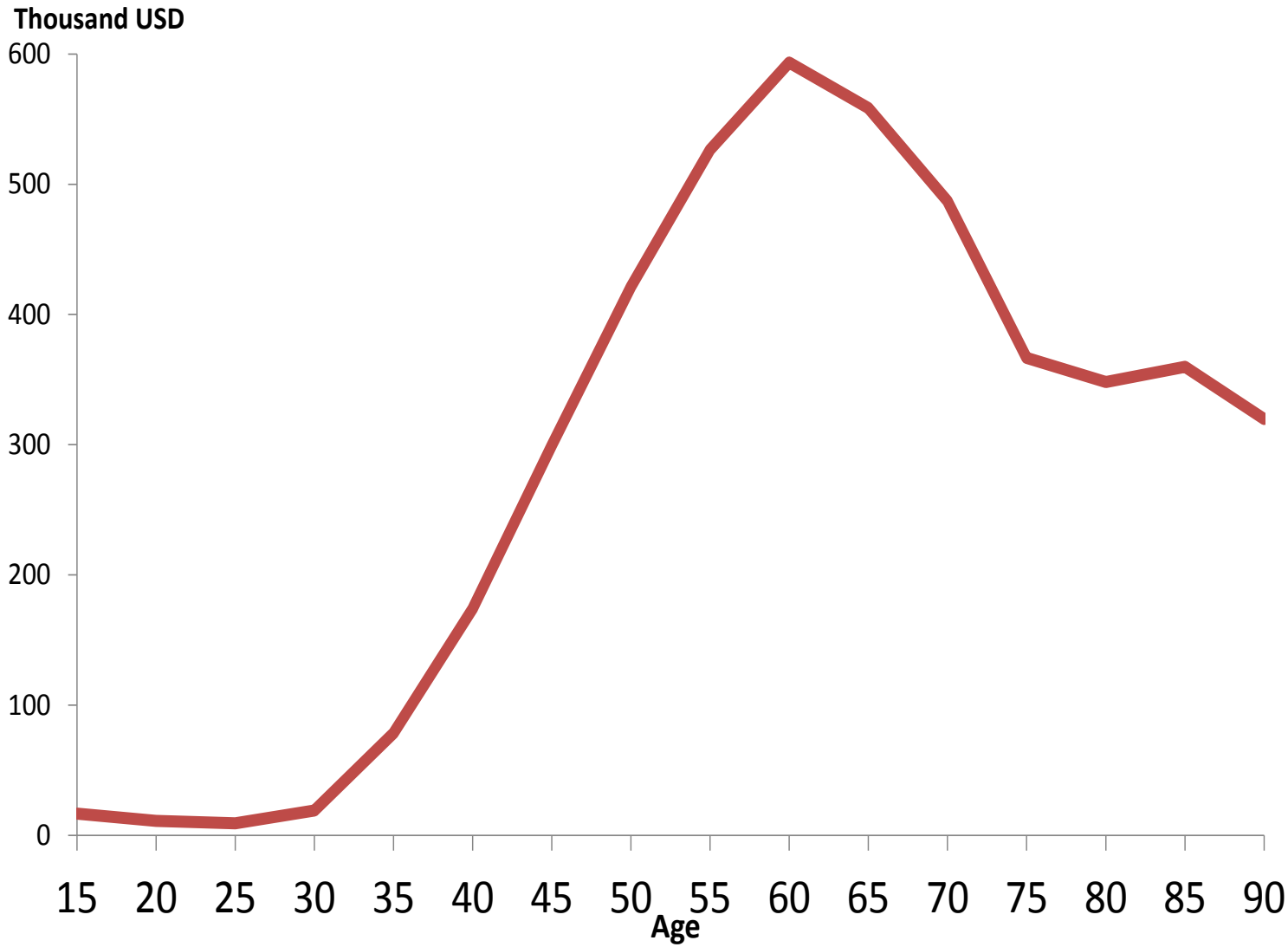
Intuition: How demographics affect interest rates



Intuition: Age-wealth profile in the US



Source: Survey of Consumer Finances, Average Net Worth excl. Housing, 1989-2013

Related literature

- Closed economy: Carvalho et al (2016), Eggertsson et al (2017), Gagnon et al (2016), Marx et al (2016)
- Open economy: Backus et al (2014), Domeij and Floden (2006), Krueger and Ludwig (2007)

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Model: overview

- **Calibrated neoclassical overlapping generations** model
- Households value **consumption, housing** and bequests
- They face a given **life-cycle profile of labour earnings**
- Net **savings of households invested** by firms
- Demographic change: variable **birth rates and life expectancy**
- Solved assuming **perfect foresight**

Model: Household's Problem

The household born at time t maximises:

$$\max_{\{c_{\tau,t},\, a_{\tau,t},\, h_{\tau,t}\}_{\tau=1}^{T}} \quad \sum_{\tau=1}^{T} \beta_\tau \tilde{\psi}_{\tau,t} \left(\ln c_{\tau,t} + \theta_\tau \ln h_{\tau,t}\right) + \beta_T \tilde{\psi}_{T,t} \phi \ln a_{T,t}$$

subject to, for $\tau = 1, ..., T$:

$$c_{\tau,t} + a_{\tau,t} + p^h_{t+\tau-1}(h_{\tau,t} - h_{\tau-1,t}) \leq w_{t+\tau-1}\epsilon_\tau l_{\tau,t} + (1 + r_{t+\tau-1})a_{\tau-1,t} + \pi_{\tau,t}$$

τ: age ; t: birth year
$\tilde{\psi}_{\tau,t}$: survival probability up to age τ
Inelastic labor supply
Fixed number of periods when the household is able to "move"; otherwise, we impose $h_{\tau,t} = h_{\tau-1,t}$.

Model: Firm's Problem

At each period t, the firm maximises:

$$\max_{L_t, K_t} \quad F(K_t, L_t) - w_t L_t - (r_t + \delta) K_t$$

$$F(K, L) = A \left[(1 - \alpha) L^{\frac{\sigma - 1}{\sigma}} + \alpha K^{\frac{\sigma - 1}{\sigma}} \right]^{\frac{\sigma}{\sigma - 1}}$$

Model: Market Clearing

$\tilde{X}_t$: value of X_t per aggregate capita.

Market Clearing at every period t:

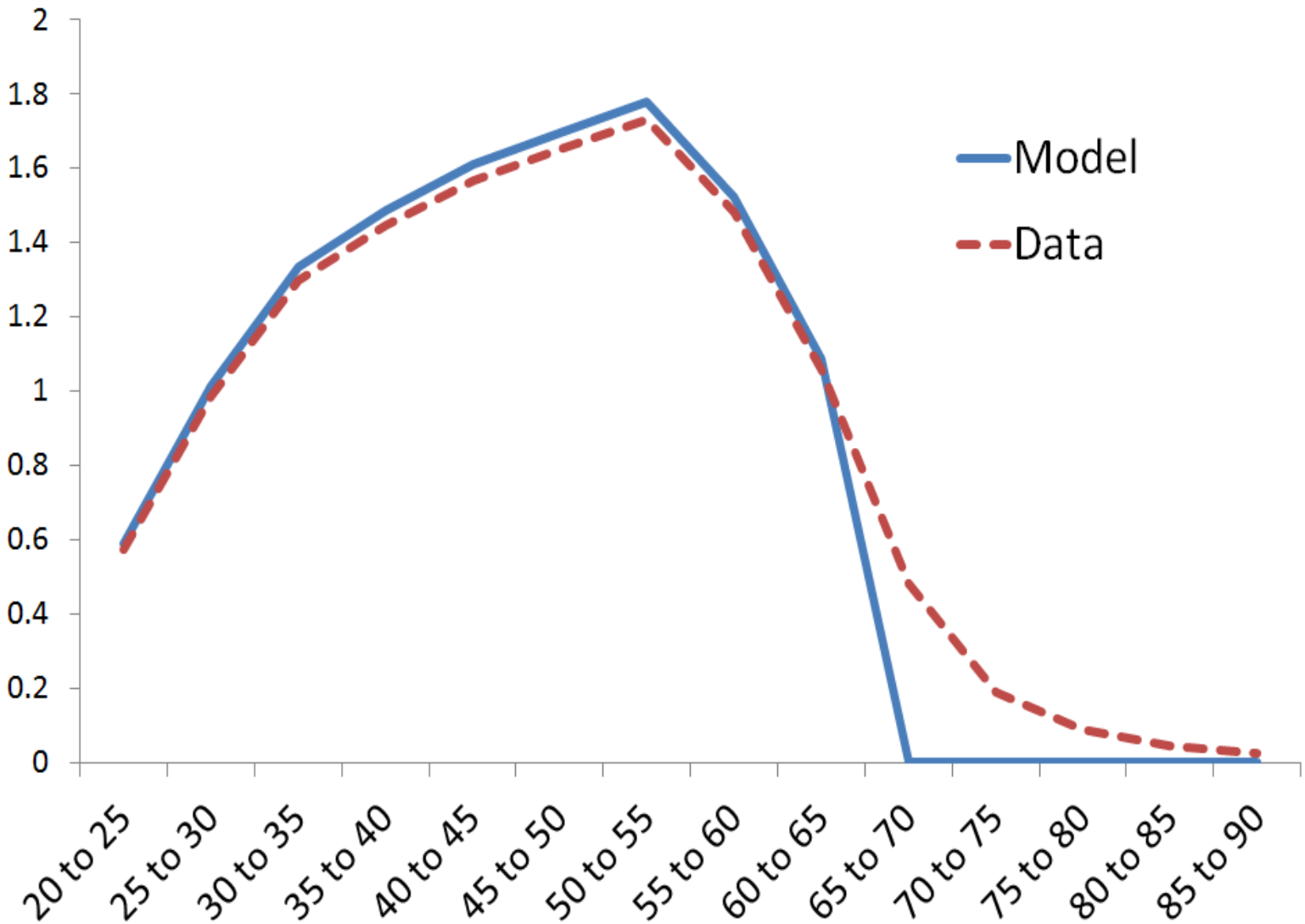
- Capital/Asset Market
$$\tilde{A}_{t-1} = \tilde{K}_t$$
- Labour Market
$$\tilde{\rho}' \epsilon \mathbf{l}_t = \tilde{L}_t$$
- Housing Market
$$\tilde{H}_t = \tilde{H}$$
- Goods Market
$$\tilde{Y}_t = \tilde{C}_t + \tilde{I}_t$$

Steady state exists in per capita terms.
Housing supply exogenously increases with total population size.

Calibration

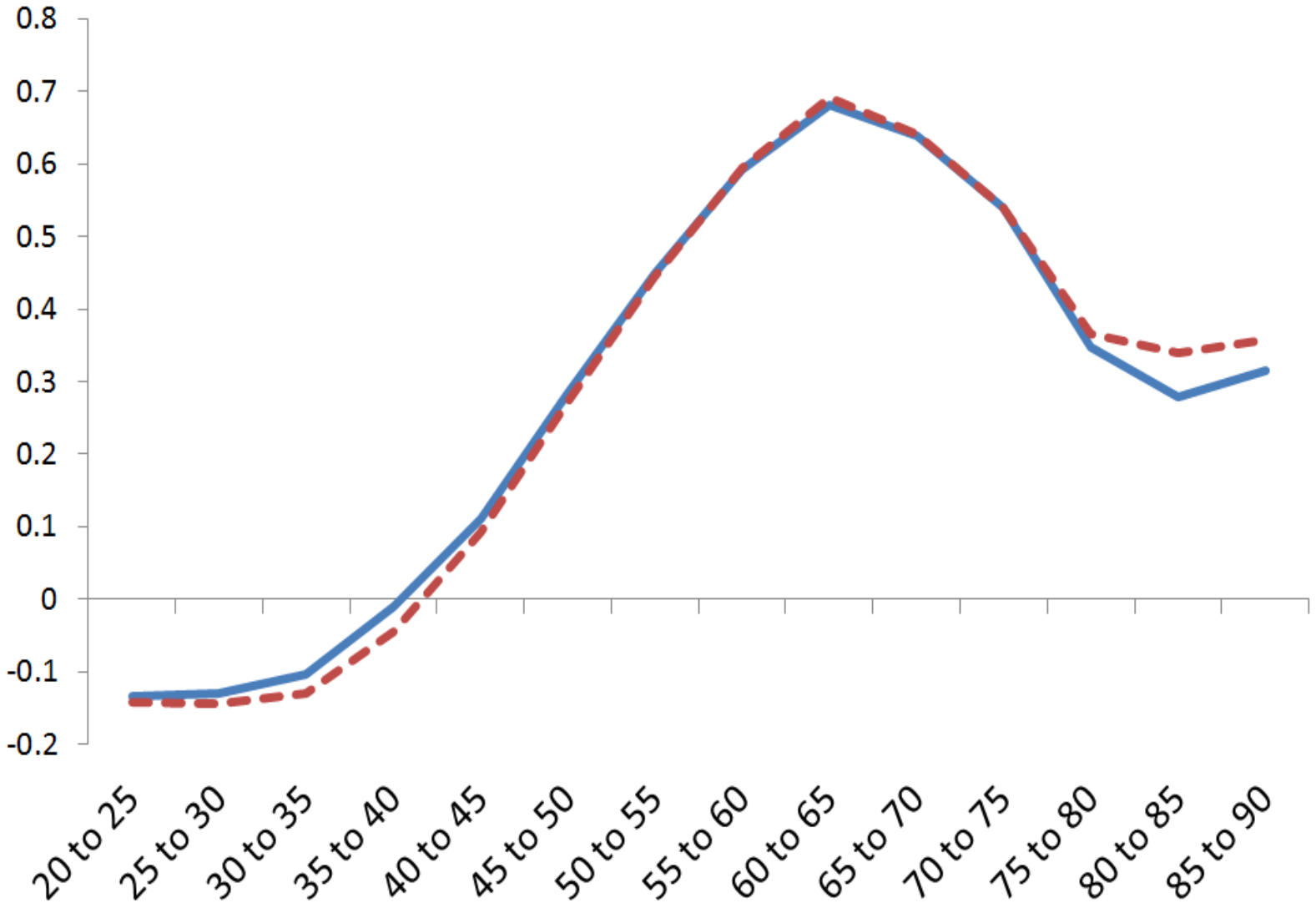
- Average **aggregate** values for advanced economies in the 1970s
  - World interest rate: 3.7%
  - Housing wealth/GDP ratio: 145%
  - Credit/GDP ratio: 45%
- **Life-cycle patterns** from the US Survey of Consumer Finances, from 1989 to 2013
  - Labour productivity
  - Net wealth (excluding housing)
  - Housing wealth
- **Demographics data** for advanced economies: Western Europe, North America, Japan, Australia, New Zealand ▸ details

Calibration: Labour productivity



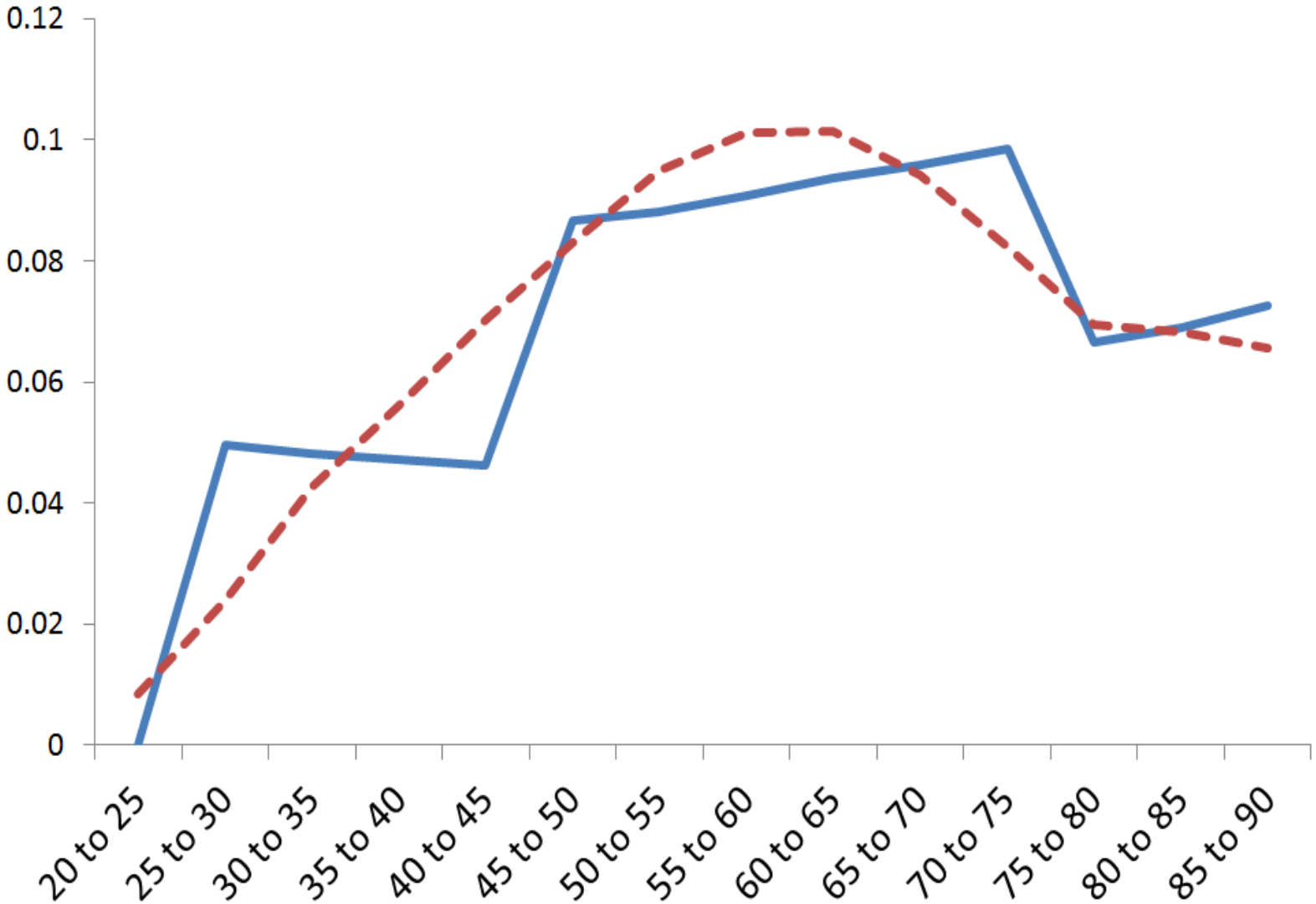
Source: Survey of Consumer Finances, Labour income, 1989-2013

Calibration: Net worth (excl. housing)



Source: Survey of Consumer Finances, Average Net Worth excl. Housing, 1989-2013

Calibration: Housing wealth



Source: Survey of Consumer Finances, Housing wealth, 1989-2013

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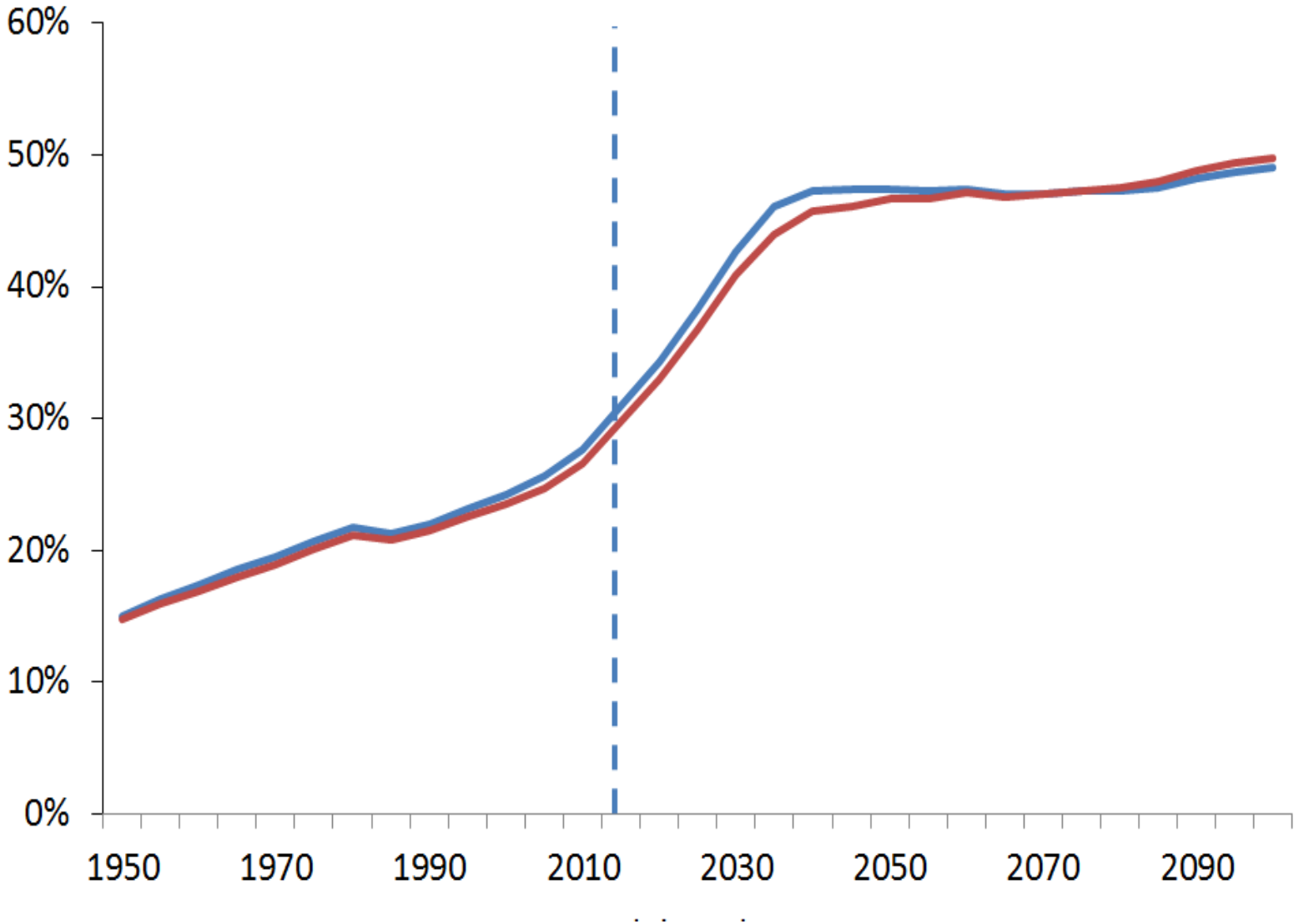
Using the model

- Incorporate both the baby boom and the increase in life expectancy in our model
- Compute the transition from the 1950s to the 2100s according to the UN population predictions
- Match the data in the 1970s
- Let the model speak before and after these dates

Calibration: Demographic change

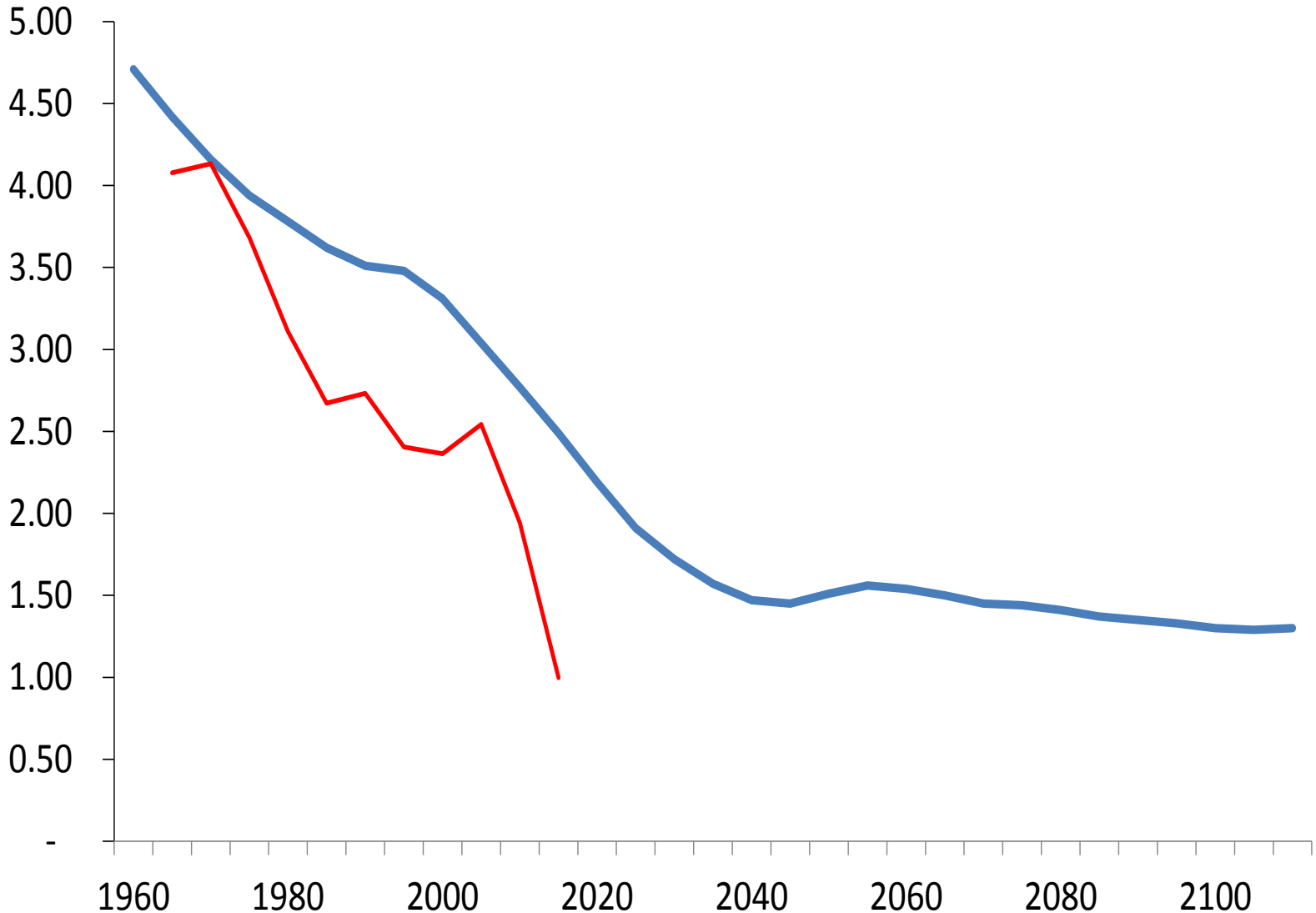


Blue: model, Red: data (UN Population Statistics)

Results overview

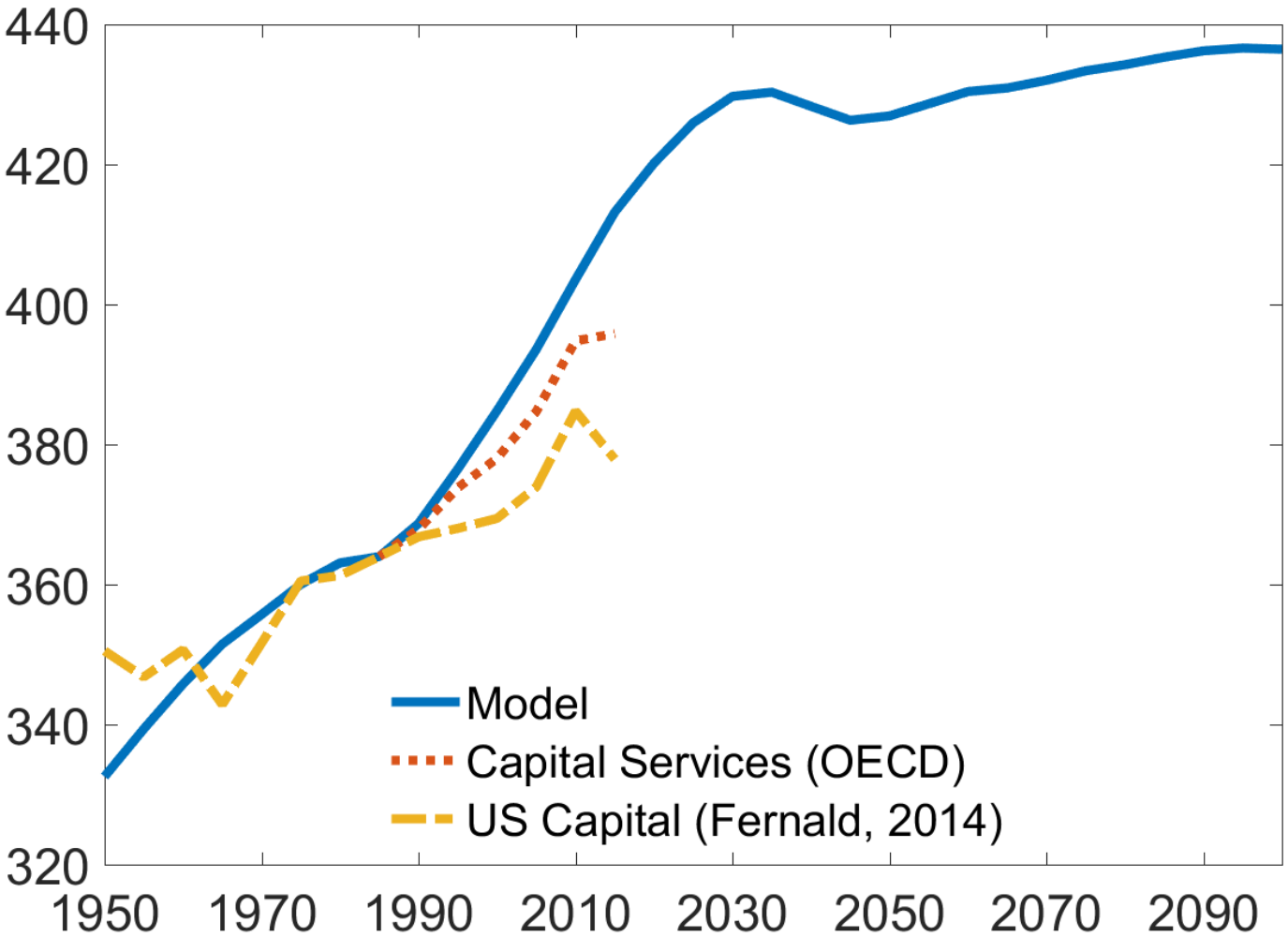
- Savings, **debt** and the **interest rate**
- **House prices** and the role of housing
- Labour **productivity**
- **Open economy** implications

Model outcome: Natural interest rate

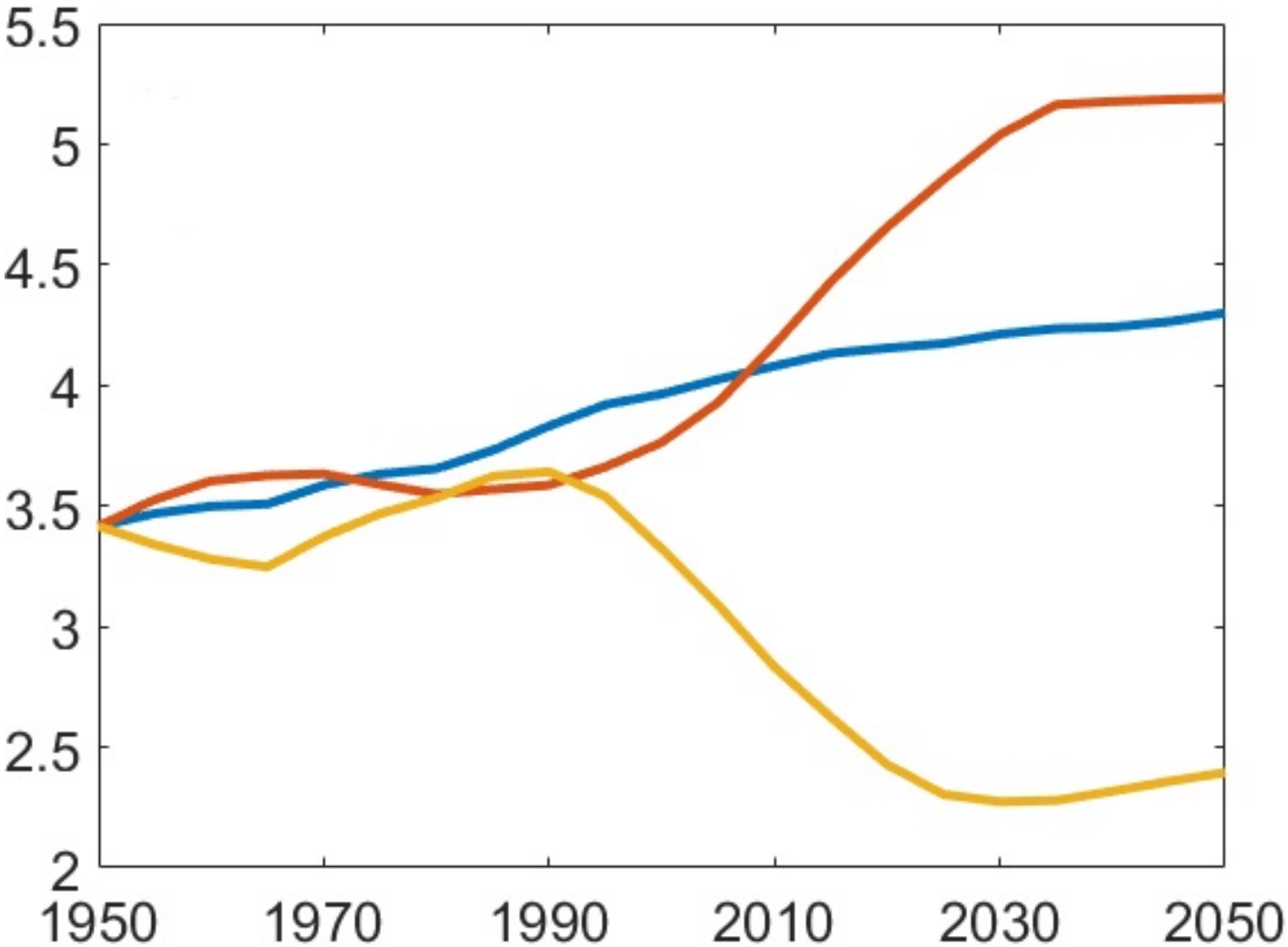


Blue: model, Red: data (Holston-Laubach-Williams Average)

Model outcome: capital-output ratio

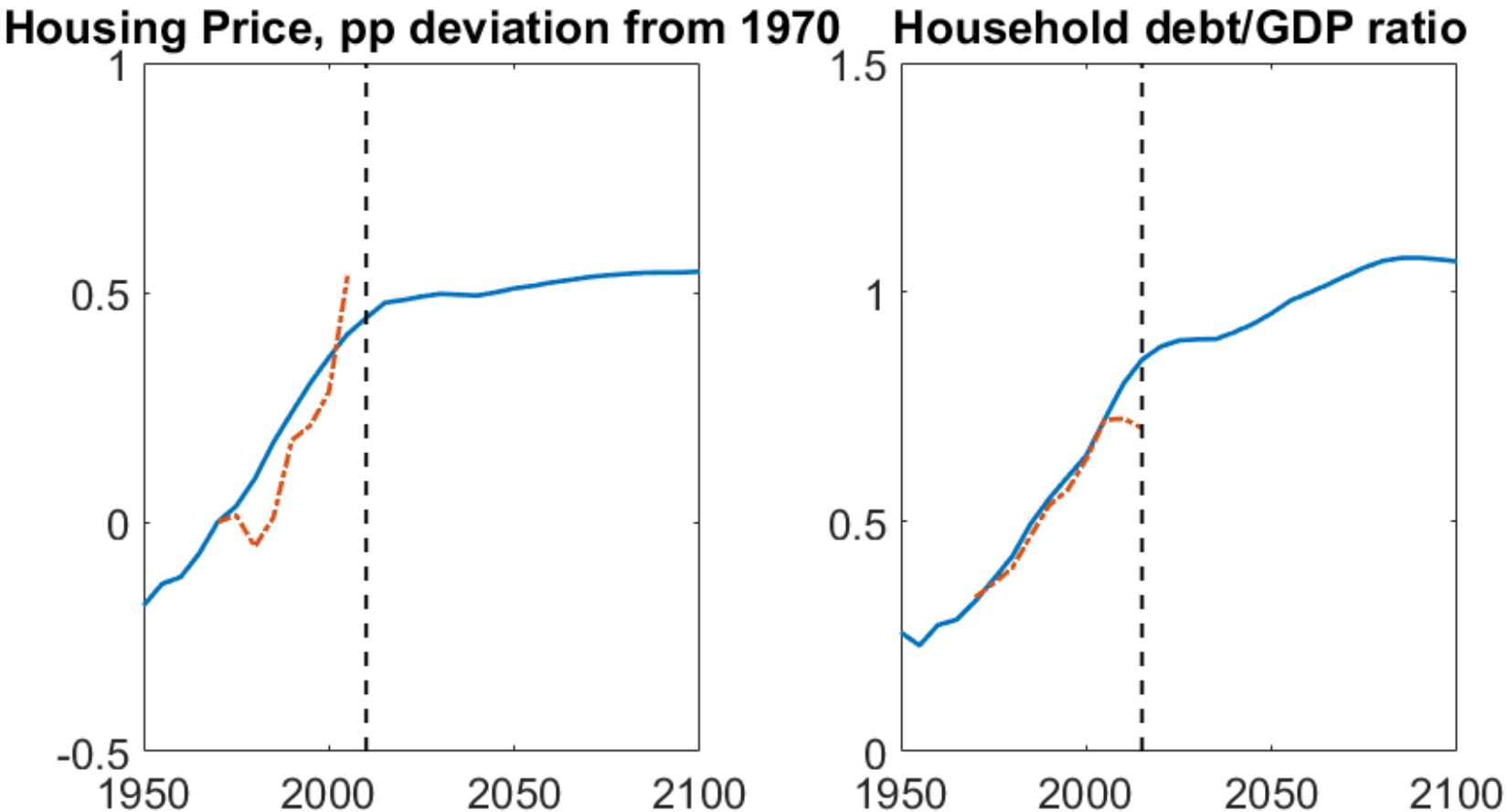


Model outcome: Decomposing the drivers of savings



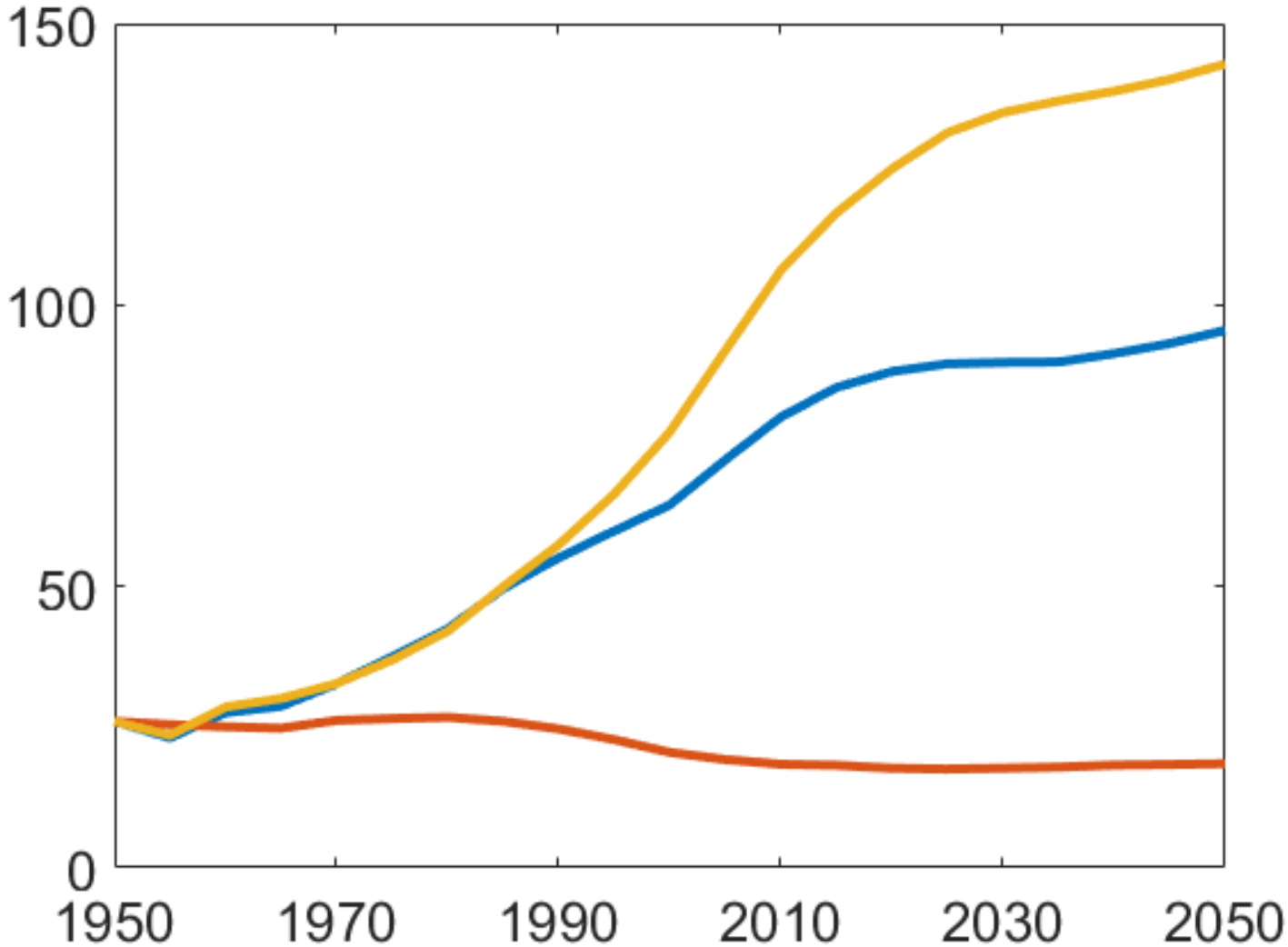
Blue: full simulation
Red: changing only the population age structure
Yellow: changing only the household's optimal behaviour

Model outcome: Housing and credit



Blue: model, Red: data (BIS, Private credit, House price index)

Model outcome: Decomposing the drivers of debt



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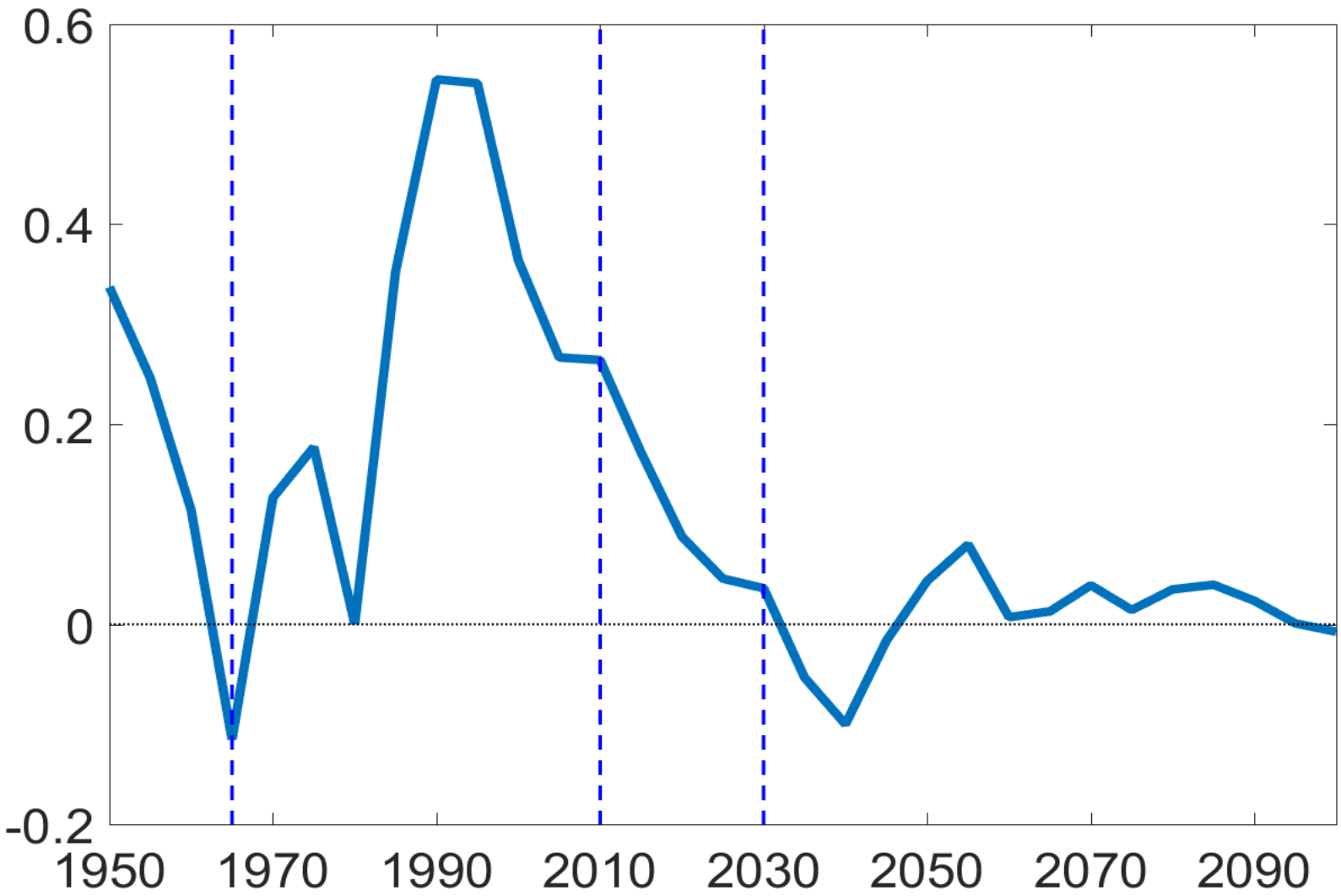
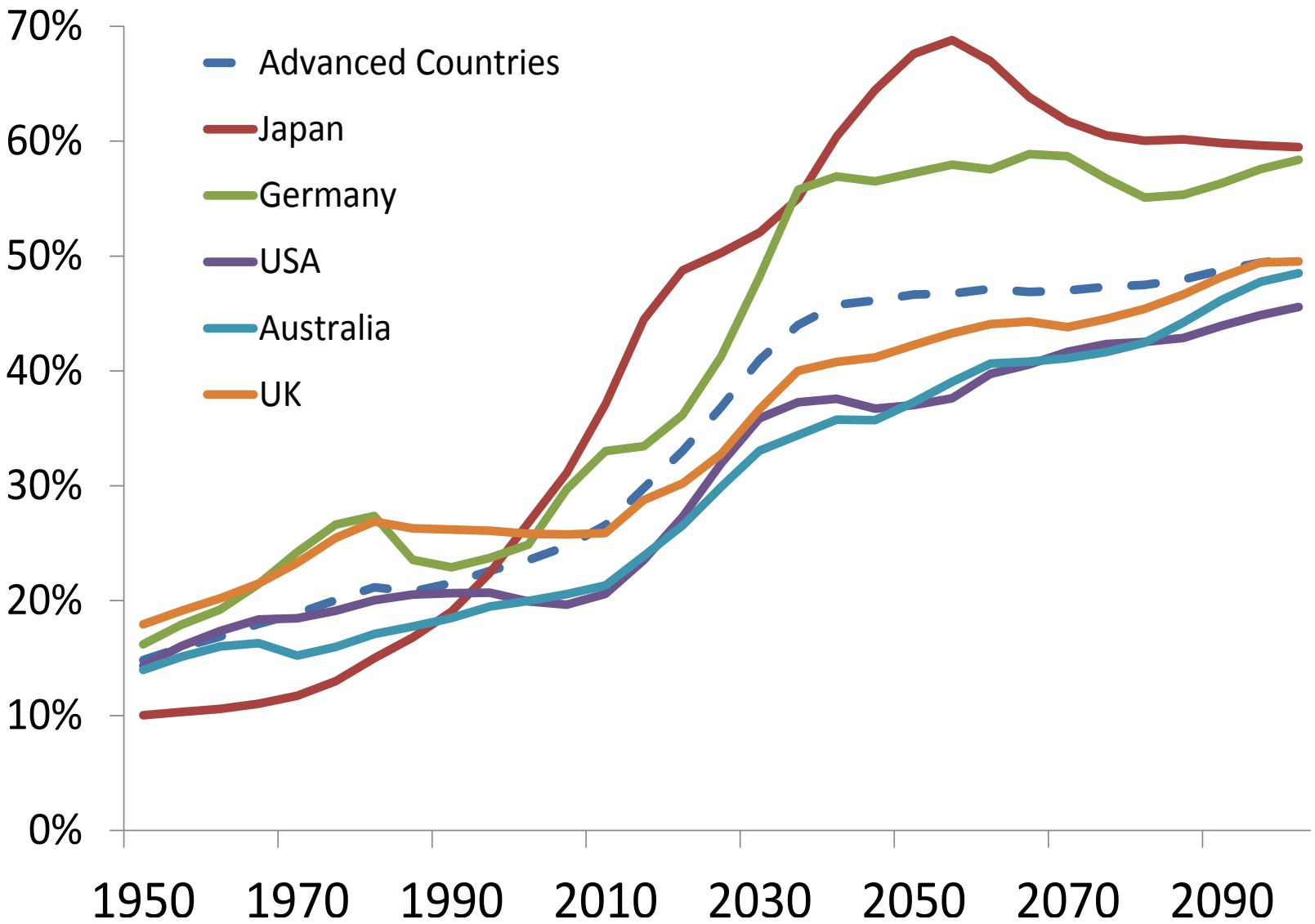
Model outcome: Labour productivity



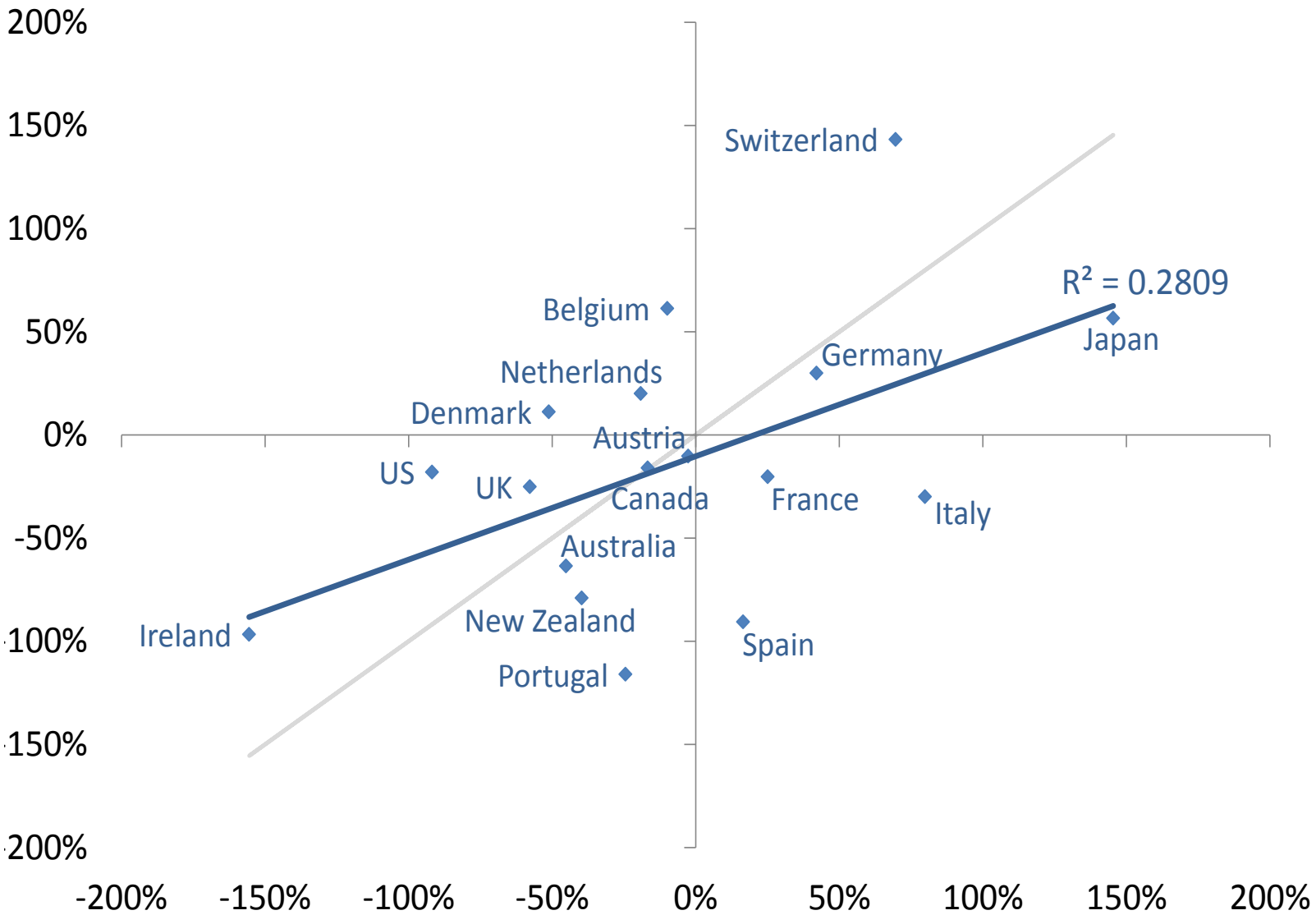
Deviation from trend, annualised growth

Open economy: OADR across countries



Source: UN Population Statistics

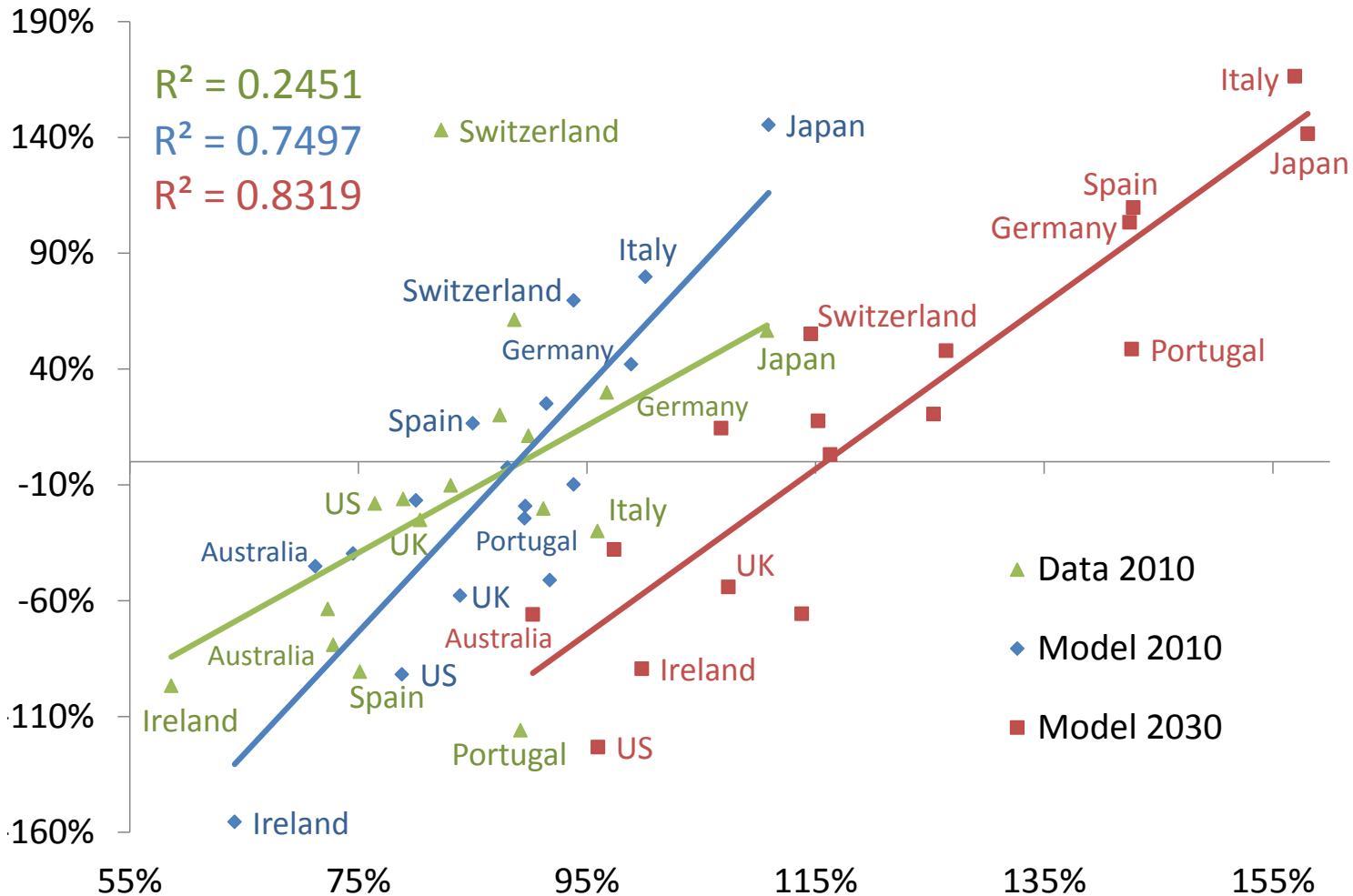
Open economy: Model vs data



Model on x-axis and Data on y-axis, grey line is the 45 degree line.

Open economy: model predictions

Demographic Changes and NFA accumulation



Note: HWR on x-axis and NFA/GDP on y-axis.

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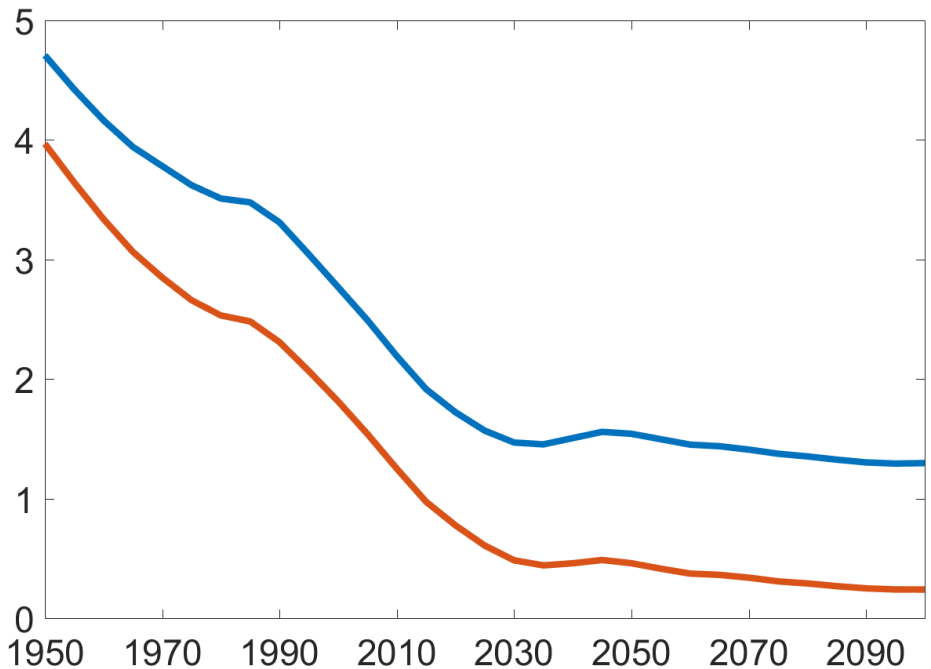
Sensitivities and extensions

- Housing
- Monopoly profits
- Retirement age

Sensitivities and extensions: housing

- Housing facilitates life-cycle saving, somewhat attenuating effects of demographics
- Prevents negative interest rates

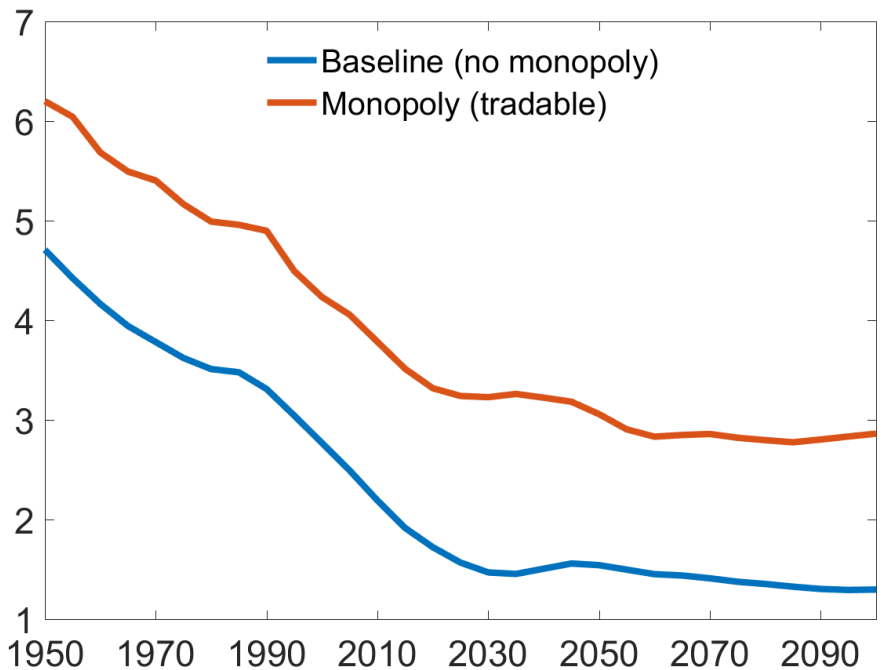
Figure: Simulations With and Without Housing



Sensitivities and extensions: monopoly profits

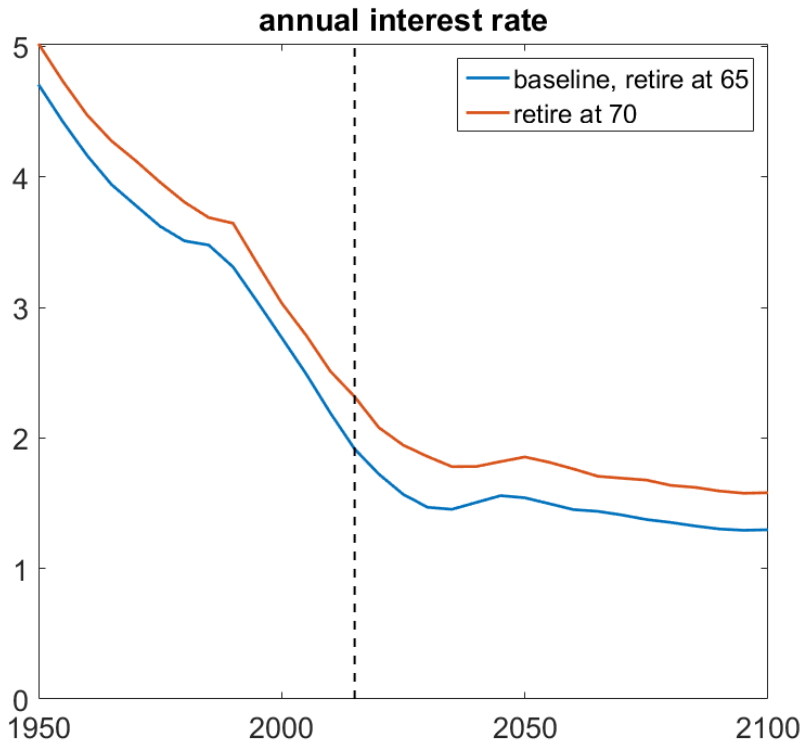
- Add monopolistic competition and supernormal profits to the corporate sector.
- In partial equilibrium, this pushes down on the interest rate $r_t = \frac{1}{\mu}\frac{\partial Y_t}{\partial K_t}$
- Tradable claims constitute an additional store of value, again attenuating fall and

Figure: Simulations With and Without Monopoly Power



Sensitivities and extensions: retirement age

Simulations varying retirement age by 5 years



Effects of retirement age increase surprisingly small

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Conclusions and some caveats

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- Population ageing mostly due to **persistent rise in longevity**
- Explain around half the **fall in real interest rates** since the 1980s, most of the **rise in house prices and household debt** and about 30% of **cross-sectional variation in NFA** positions.
- Potentially permanent implications

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Caveats:

- We have assumed **perfect foresight**, but not everyone plans ahead
- Not all the pressure of demographic change will fall on **private savings**
  - Retirees can instead **consume less** (no evidence so far)
  - Households will **work more**, or retire later (already some evidence)
  - Governments will provide part of the old-age pensions through **contemporaneous transfers**
- This is **not a forecast** that rates will remain low - many other factors at play

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Thank you!

Country list

Country list for UN population data: Australia, Austria, Belgium, Canada, Denmark, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Portugal, Spain, Switzerland, United Kingdom, United States of America

Population approximation before 1950: Belgium, Canada, Denmark, France, Italy, Netherlands, Spain, Switzerland, UK, USA

▸ Back