Longevity and growth in Sweden: 1750-2100

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Facts

- Longevity has increased substantially in the last two centuries
  - Life expectancy at age 10 = 46 years in 1750
  - It is equal to 70 in 2000
  - Adult life is 24 years longer than in 1750

  (not taking into account improvements in infant mortality)
- It is expected to increase even further
  - Life expectancy at age 10 = 75 in 2050, 78 in 2100

Questions

- Role of longevity in fostering the Industrial Revolution ?
- Effect of aging on growth 2000-2100 ?

Specificity of our view: provide a common approach to both phenomena

Plan of the talk

- Theoretical links between longevity and growth:
  what are the implications of a rise in longevity ?

- A quantitative model for Sweden

Theory – depreciation effect

- Total labor force = past labor force
  + entry of new workers
  - exit of retired workers
  - death of some workers
- Rising longevity implies lower death rates

  → the depreciation rate of the « stock of workers » is lower

  → the depreciation rate of the stock of human capital is lower

  → good for growth

Theory – individual saving effect

- Individuals expect to live longer,

  → more savings for their old days,

  → funding for investment in physical capital

  → good for growth

Theory – individual education effect

- Individuals are more likely to stay alive during their active life,

  investment in education is better rewarded,

  the rate of return on investment in education increases

  → longer schooling

→ good for long-run growth

Theory – age structure effects

- Higher longevity changes the age structure of the population (at constant fertility)
  - The activity rate is affected + or – (depends who benefits the most from longevity)
- Also affect the age structure of the labor force: more old workers

Theory – other effects

- Weight of experience relative to education increases in the economy

  → higher education premium, lower experience premium

- Fiscal effects: Pay-as-you-go pensions are more difficult to sustain

  →need for higher taxes

Theory – indirect effect - density of population

- Density of population increases
  - Bigger cities – speeds up the accumulation of human capital
    + more exchanges of ideas
  - Greater specialization of tasks – increase the productivity

Theory - summary

- For theory, total effect is indeterminate
- This is why quantitative evaluations are important
- Here, the quantitative exercise covers a period longer than usual: 1750-2100

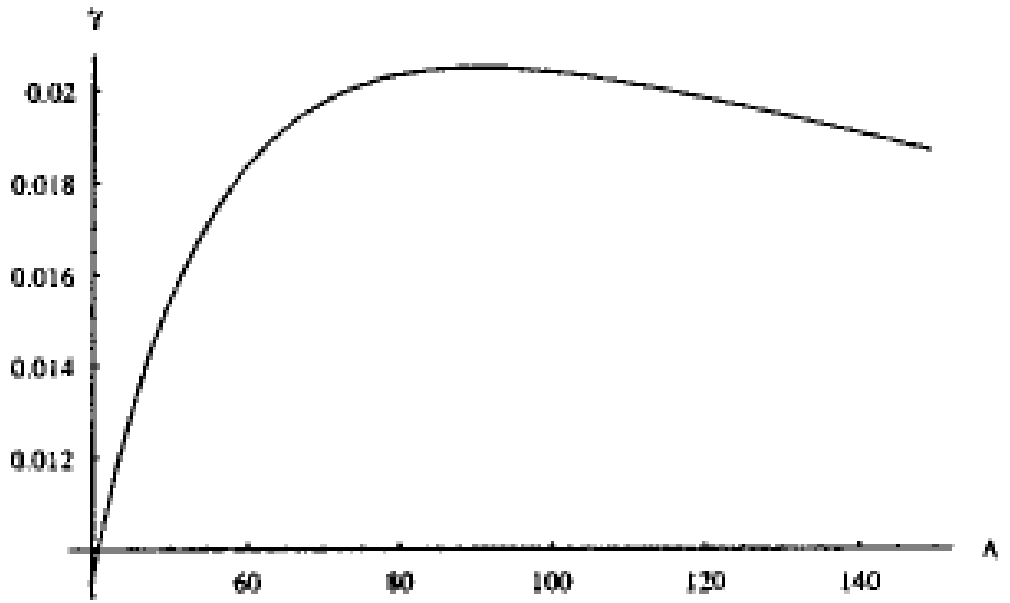
Our experiment

The model - source

- Model built with R. Boucekkine and O. Licandro to study the effects of demographics on growth.
  - Early mortality declines at the dawn of modern growth, *Scandinavian Journal of Economics*, 2003.
  - Vintage human capital, demographic trends and growth, *Journal of Economic Theory*, 2002.
  - Life expectancy and endogenous growth, *Economics Letters*, 1999.

The model

- A model where the relation between longevity and growth is hump- shaped:



The model – effect of longevity

- Higher longevity
  - increases schooling
  - fosters growth for low levels of longevity
  - Hampers growth for high levels of longevity
- Negative effect: old workers are less productive (they have obsolete skills)

The model – survival law

- Demographics in the model
  - Concave survival function:

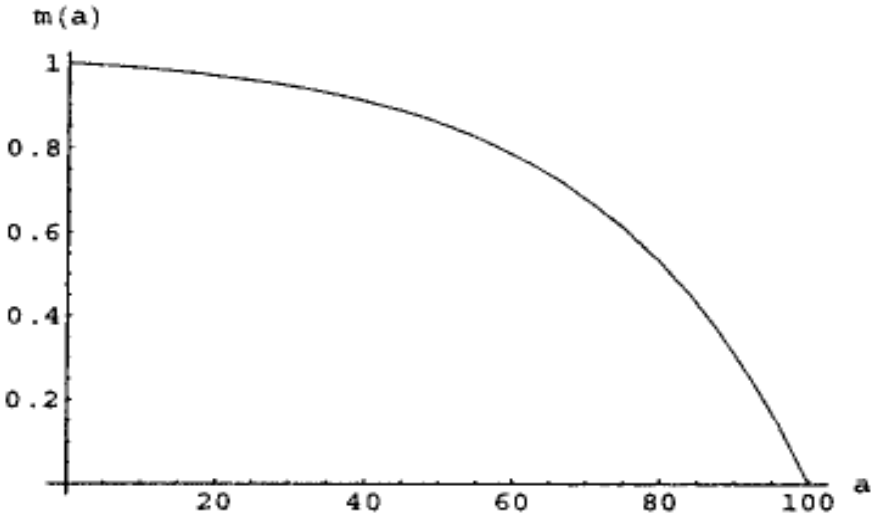


FIG. 2. Survival law.

The model – survival law

- The survival function shifts exogenously over time:

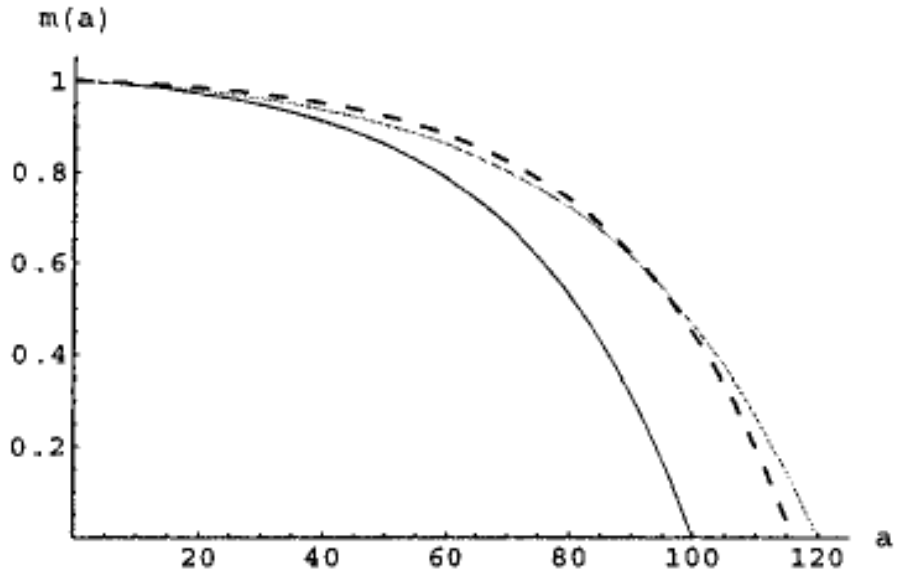


FIG. 3. Changes in the survival laws.

The model – fertility

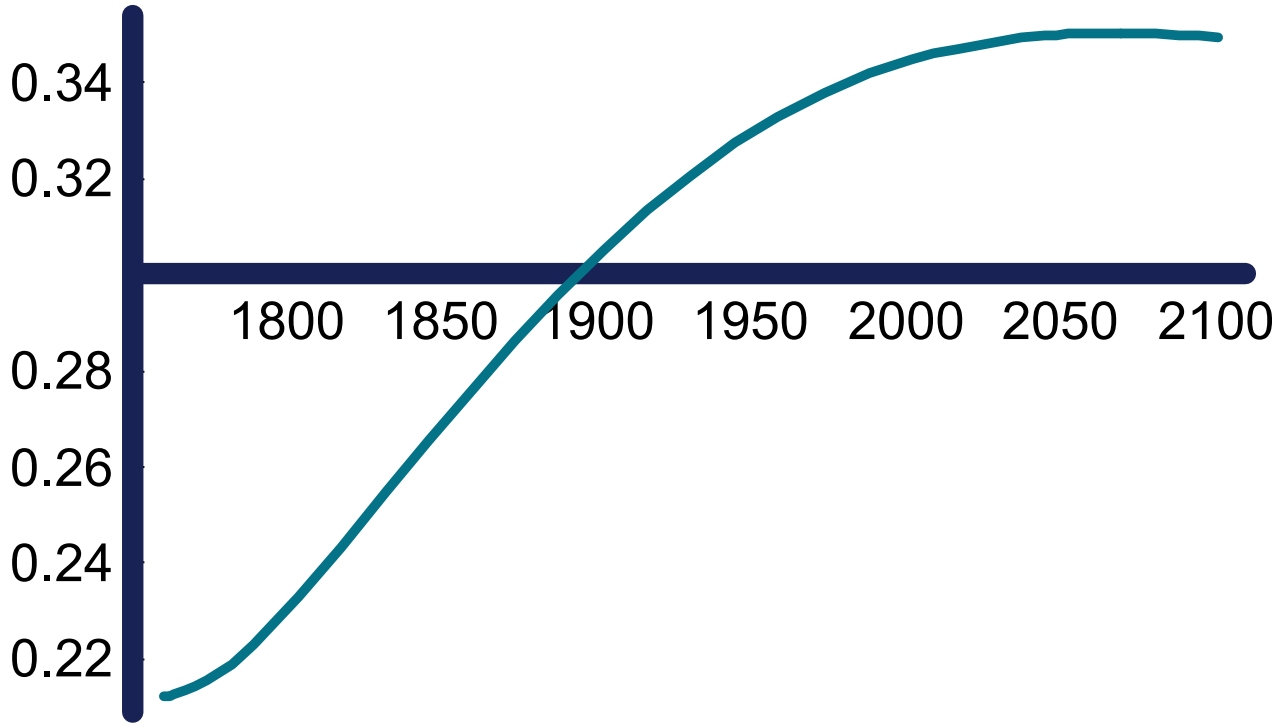
- Fertility is exogenous but not constant
  - Size of every new generations changes exogenously over time

    → effects through the age structure

- The model abstracts from children (infant mortality)

Additional effect – population density

- higher population density improves the efficiency of education:

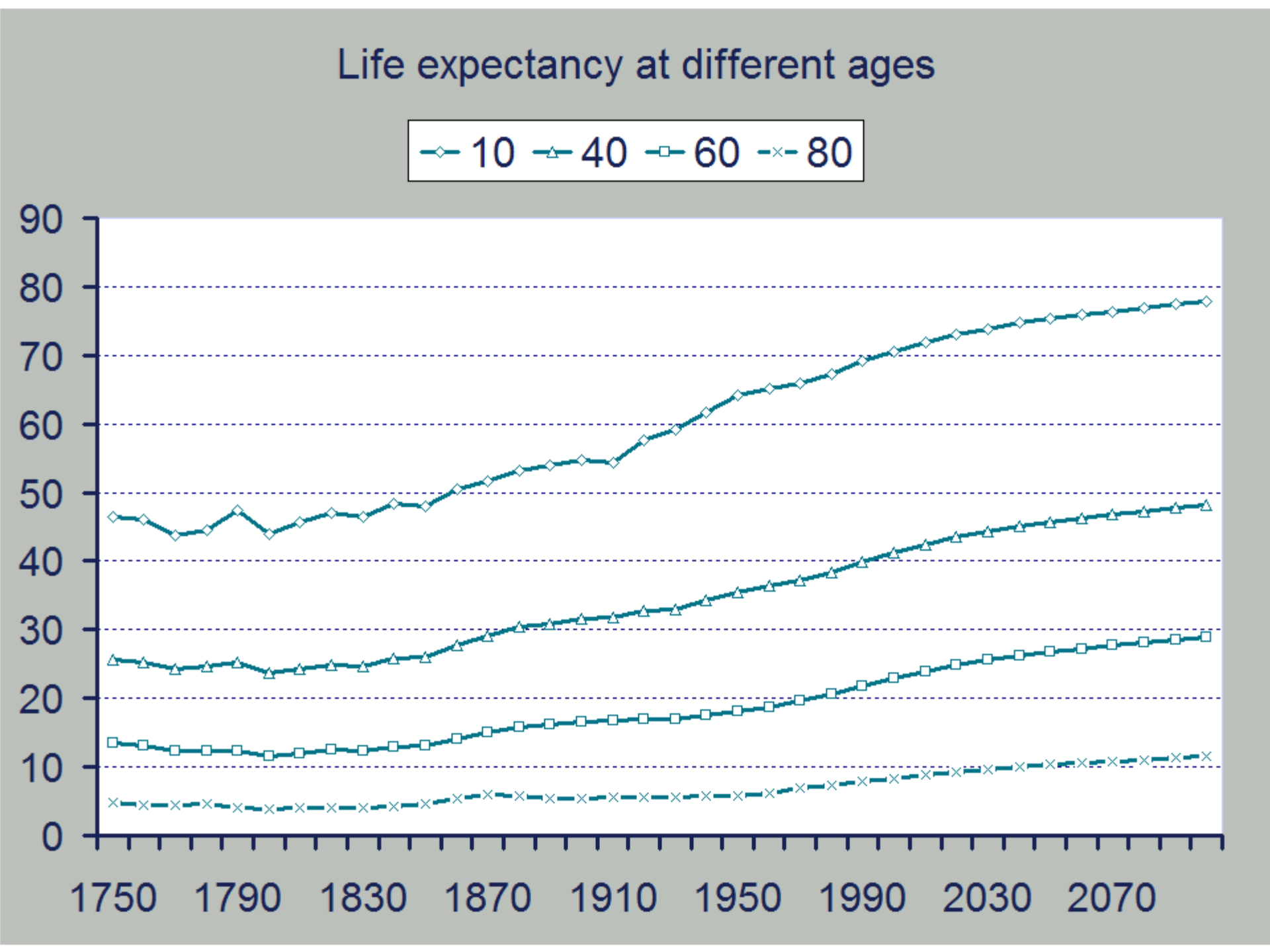


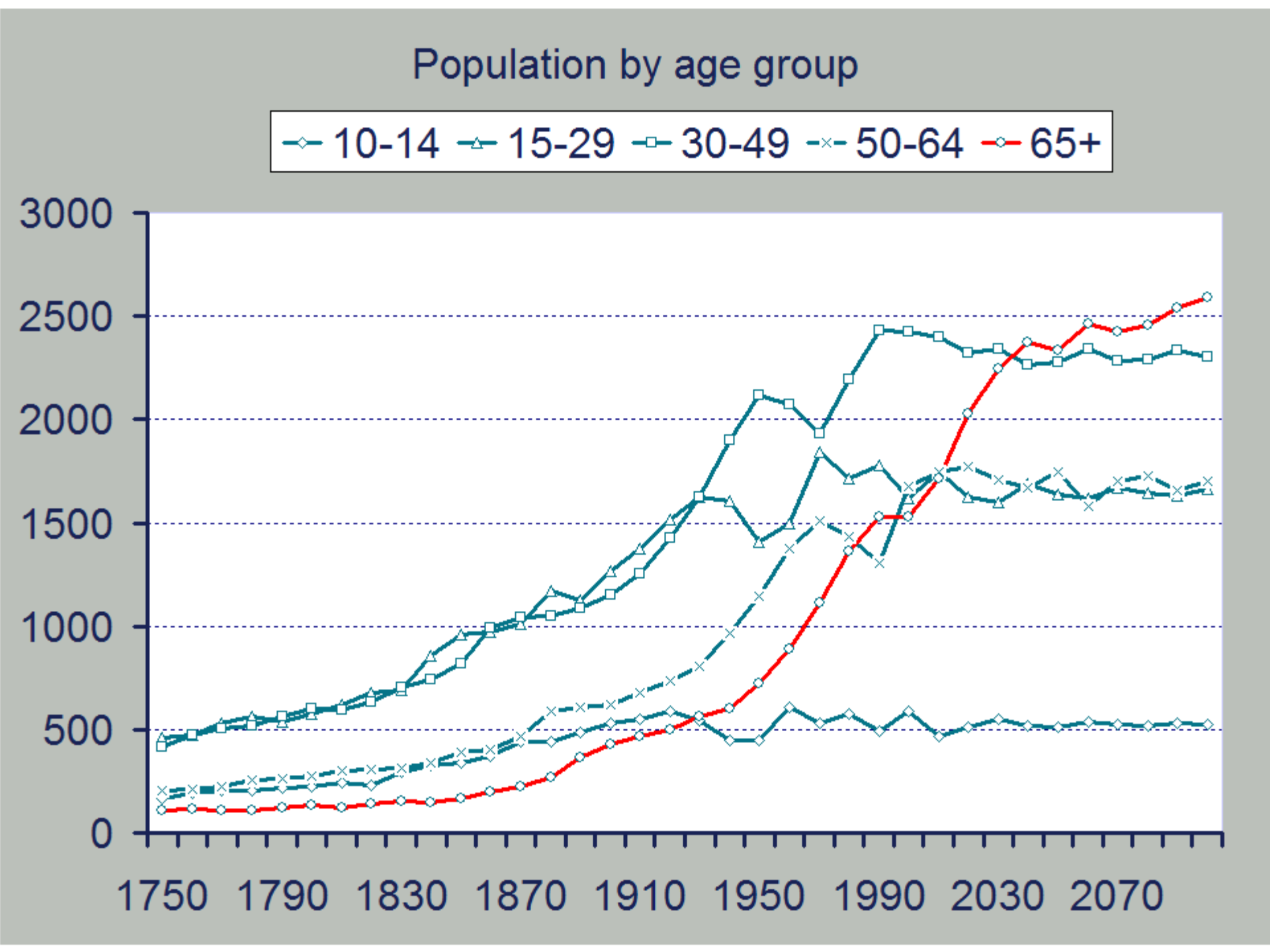
Experiment

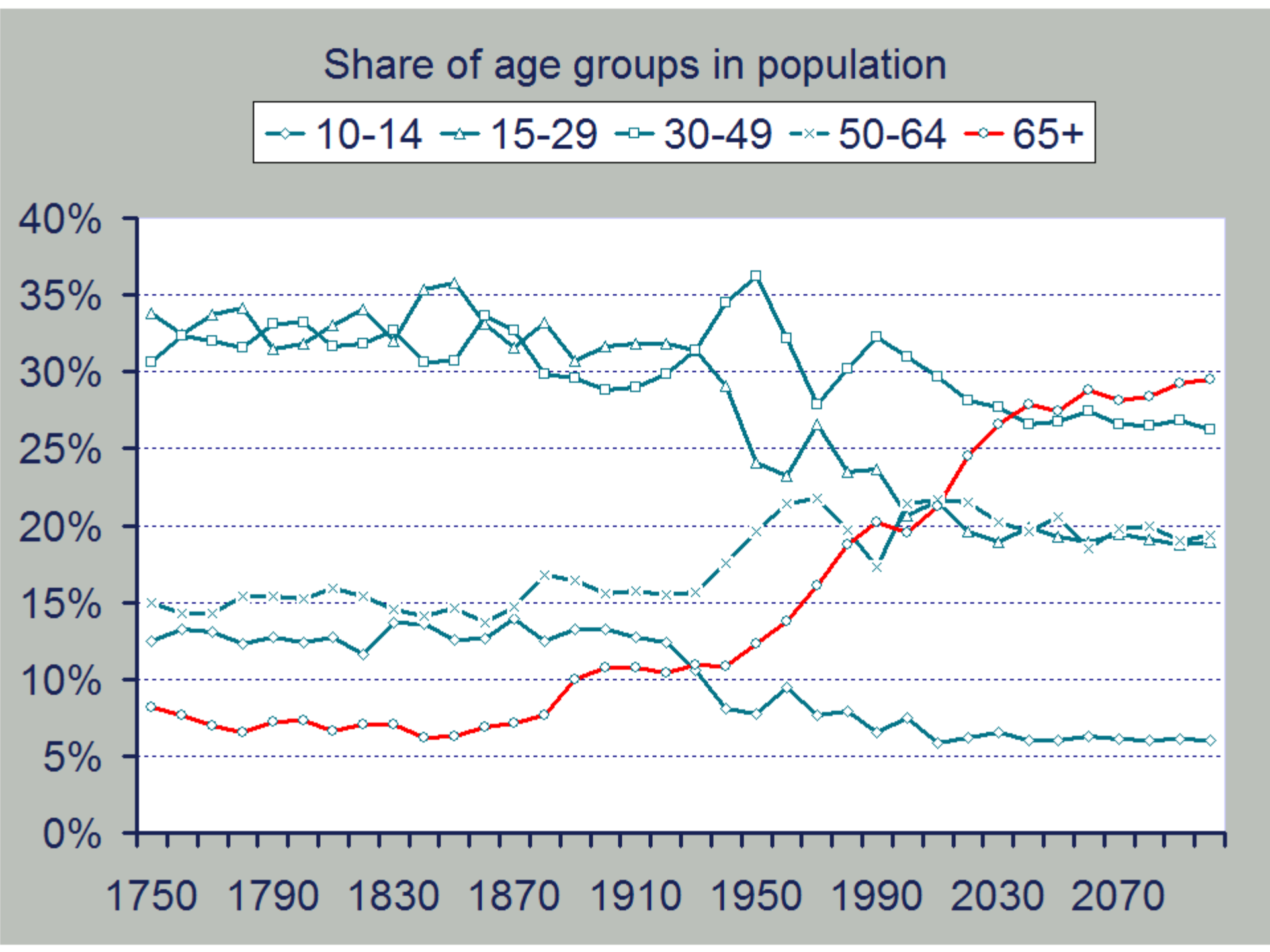
- Feed into the model actual demographics: Sweden, 1750-2100
- Output:
  - length of schooling
  - Growth of GDP per capita

Data sources

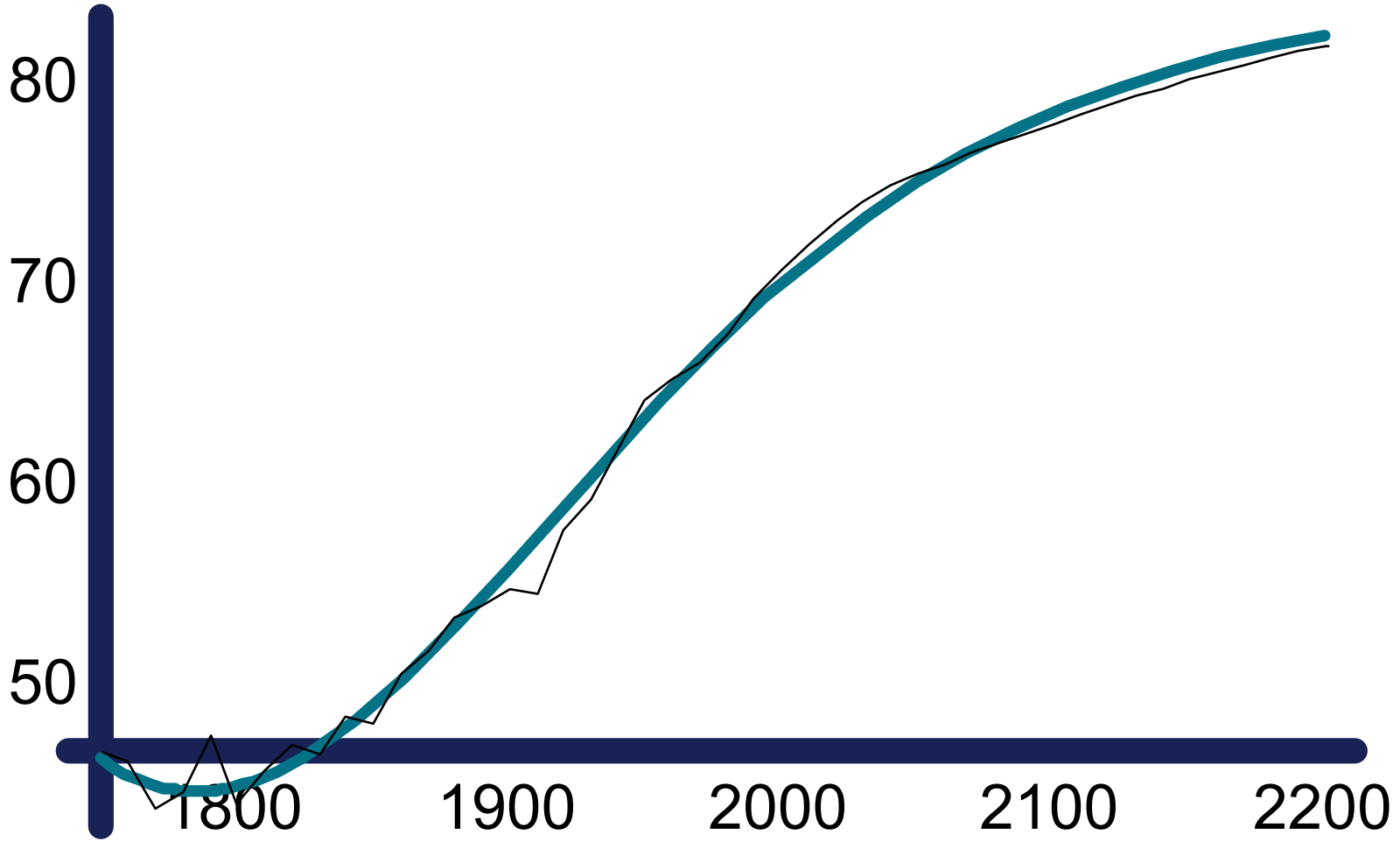
- Statistics Sweden
  - Population development in Sweden in a 250-year perspective, Demografiska rapporter 1999:2, Table 1.2, "Population by sex and age 1750-1998"
  - Sweden's Statistical databases , http://www.scb.se/ 1968-2000, 2001-2050 (forecast)
- 2050-, Extrapolation of official forecast by Bo Malmberg


Life expectancy at different ages
10
40
60
80
90
80
70
60
50
40
30
20
10
0
1750
1790
1830
1870
1910
1950
1990
2030
2070

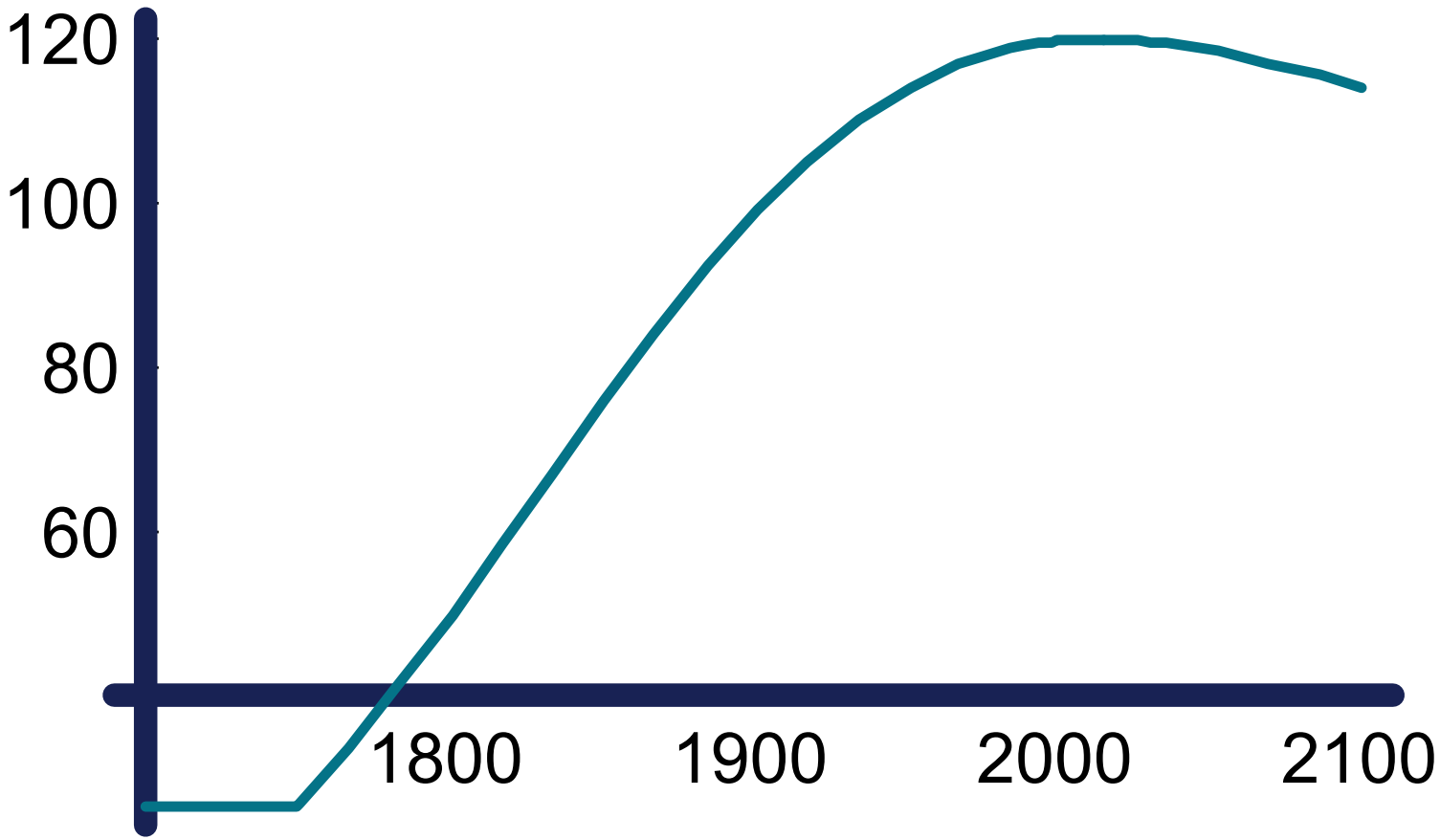

Population by age group
10-14
15-29
30-49
50-64
65+
3000
2500
2000
1500
1000
500
0
1750
1790
1830
1870
1910
1950
1990
2030
2070


Share of age groups in population
10-14
15-29
30-49
50-64
65+
40%
35%
30%
25%
20%
15%
10%
5%
0%
1750
1790
1830
1870
1910
1950
1990
2030
2070

Life expectancy at age 10



Size of the newborn cohort

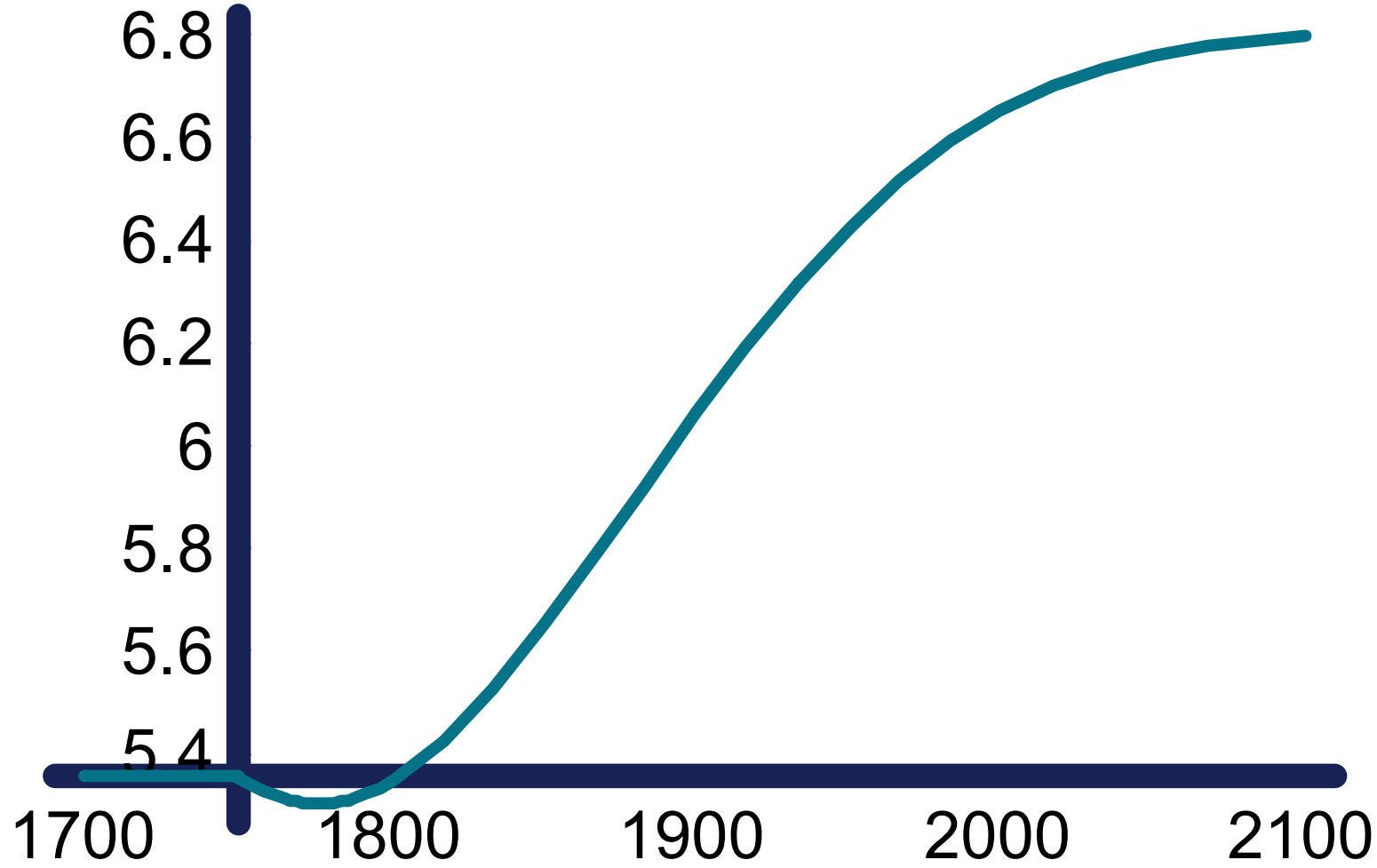


Retirement age

- We assume a constant effective retirement age of 63

Results

Output - Years of schooling after age 10



Schooling

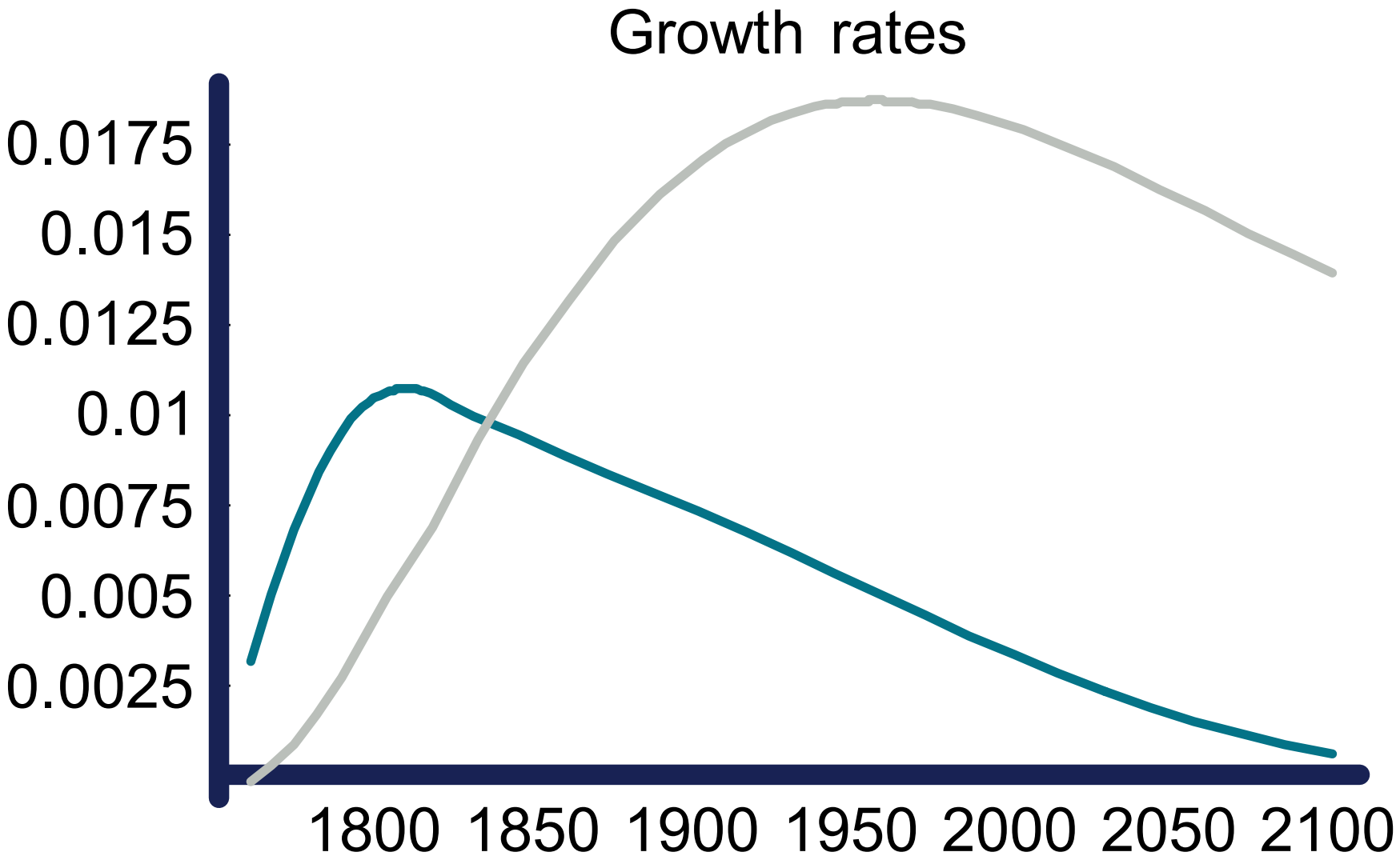
- Higher longevity explains part of the rise in schooling

  → need for another mechanism on top of longevity

- No big gains beyond 2000

Growth

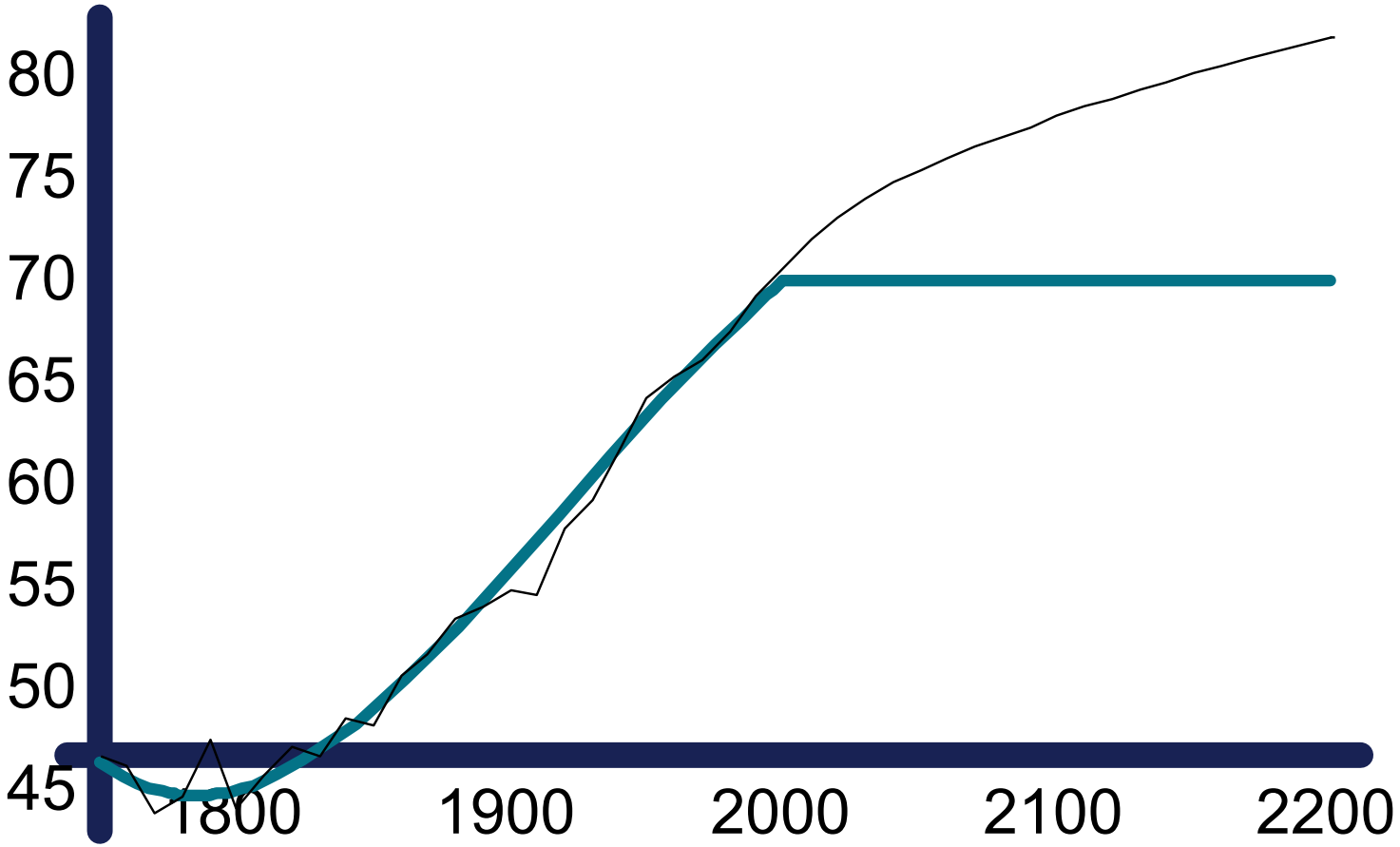
- Growth of income per capita goes from 0.1 % in 1750
- To 1.63% in 1900
- 1.81% in 1960 (maximum)
- 1.76% in 2000
- 1.58% in 2050
- 1.37% in 2100


Growth rates
0.0175
0.015
0.0125
0.01
0.0075
0.005
0.0025
1800
1850
1900
1950
2000
2050
2100

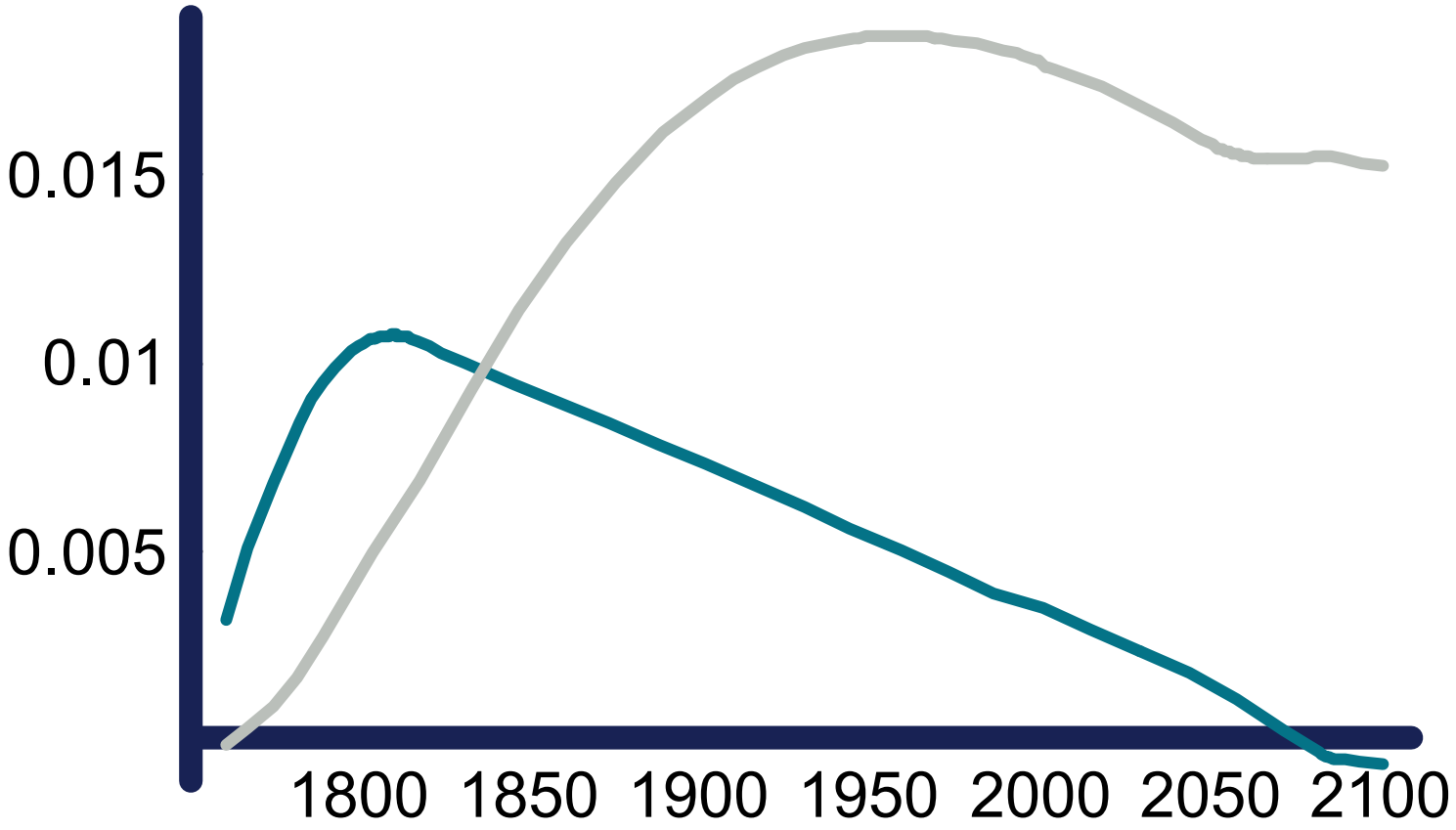
Sensitivity analysis

- What if longevity stays constant after 2000 ?

Life expectancy at age 10



Growth with constant longevity



Sensitivity analysis

- With constant longevity after 2000, annual growth rates are
  - 1.55% in 2050 1.50% in 2100
- Instead of
  - 1.58% in 2050 1.37% in 2100

  In the baseline simulation

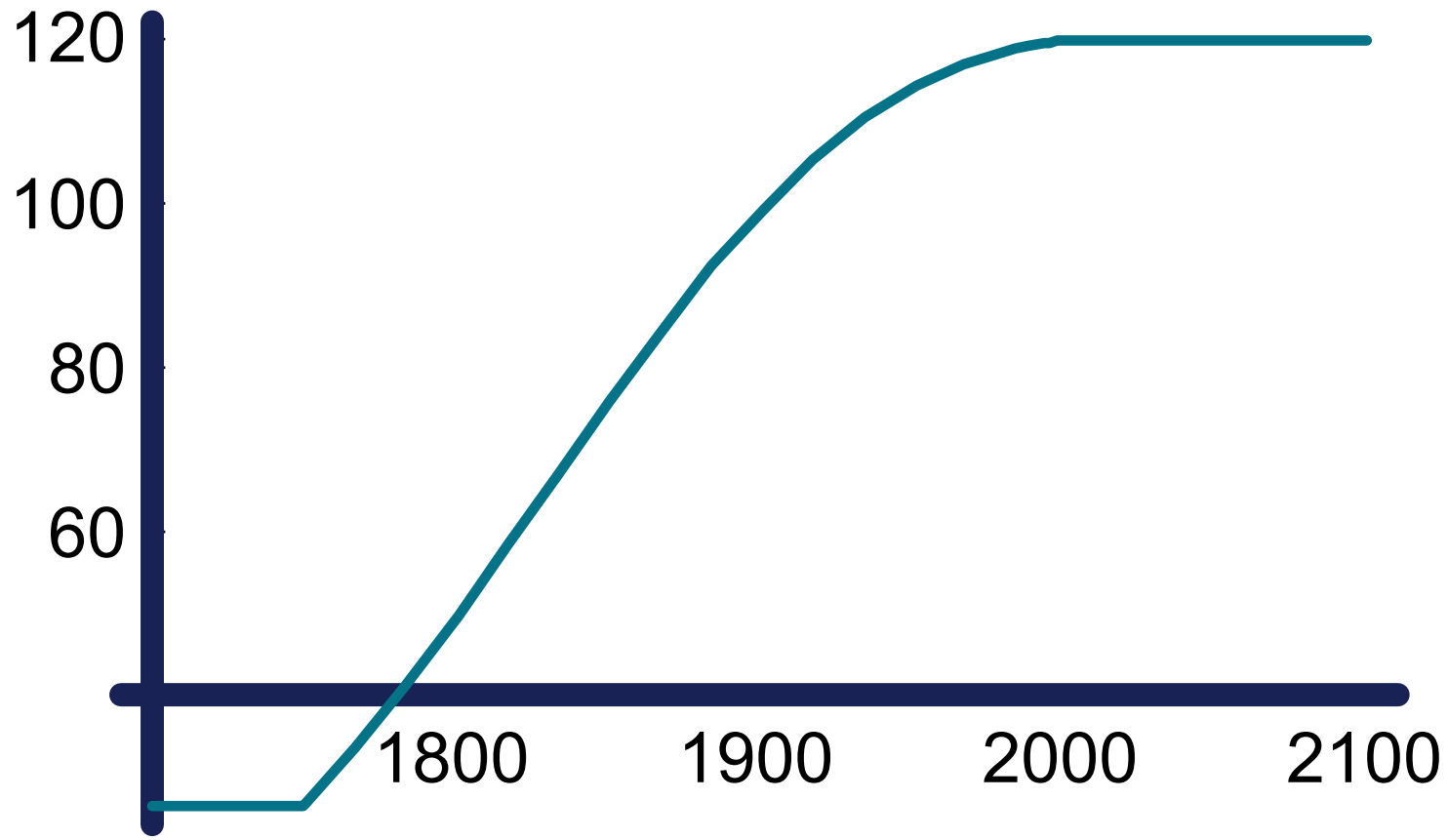
  Remark the delay in the materialization of the effect

  → Further improvements in longevity are bad for growth (but probably good for welfare?)

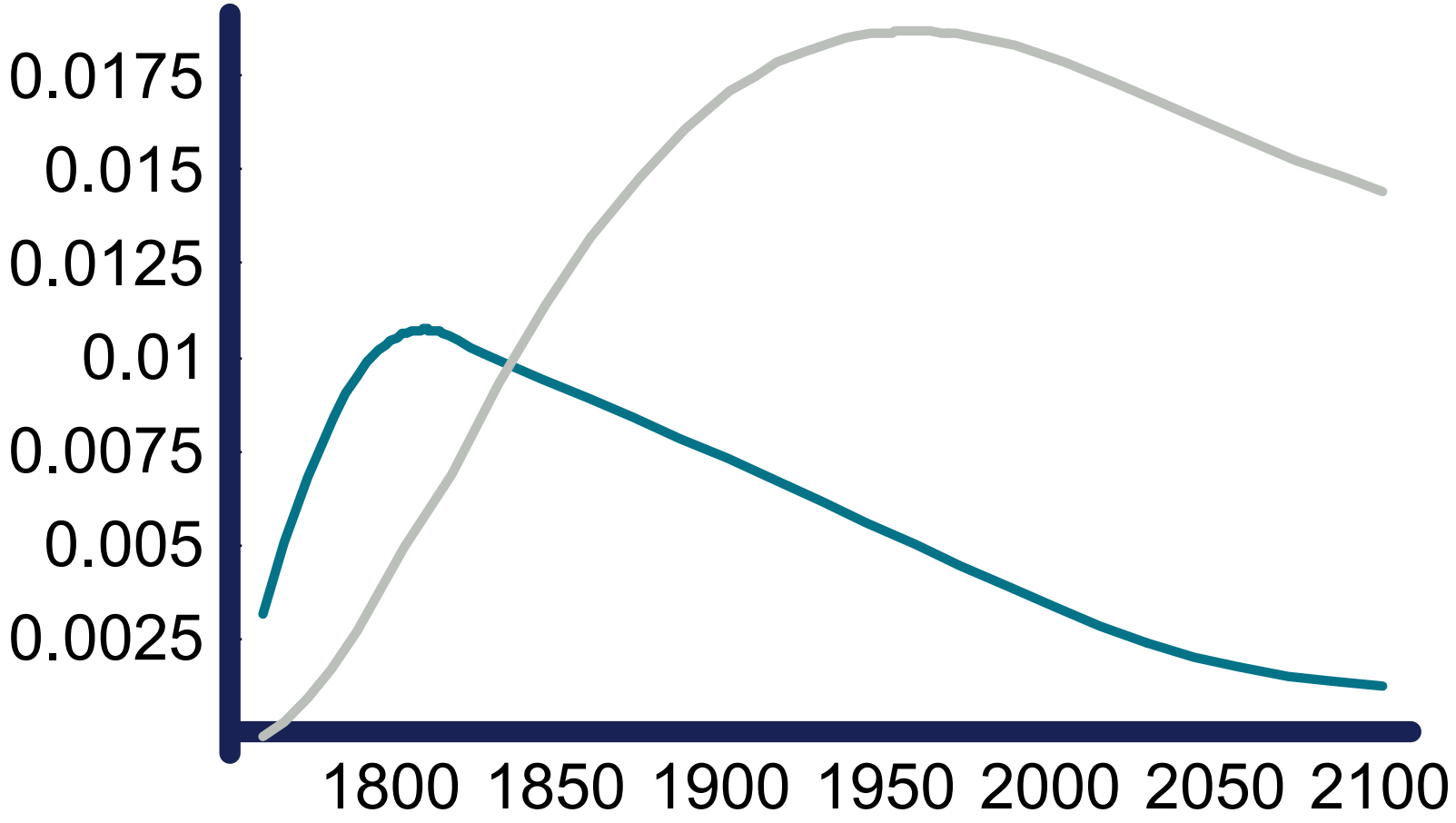
Sensitivity analysis - 2

- What if fertility increases after 2000 ?
- We run a simulation with a constant size of the newborn cohort, equal to the 2000 level.

Size of the new generation



Growth with higher fertility



Sensitivity analysis -2

- With higher fertility, annual growth rates are
  - 1.58% in 2050 1.41% in 2100
- Instead of
  - 1.58% in 2050 1.37% in 2100

  In the baseline simulation

  → very little effect

Conclusion

- Effect of demographics on growth: global analysis from the take-off in 1800 to the ageing in 2000 through the demographic transition
- Rising longevity can account for part of the rise in schooling

Conclusion - 2

- Assuming that density of population matters for growth, we can fully account for the take-off : longevity effect + density effect
- But too high longevity can be bad for growth:
  - Growth has peaked around 1960
  - Growth will lose 0.5% over the 21th century