The Demographic Transition

Oded Galor

February 9, 2025

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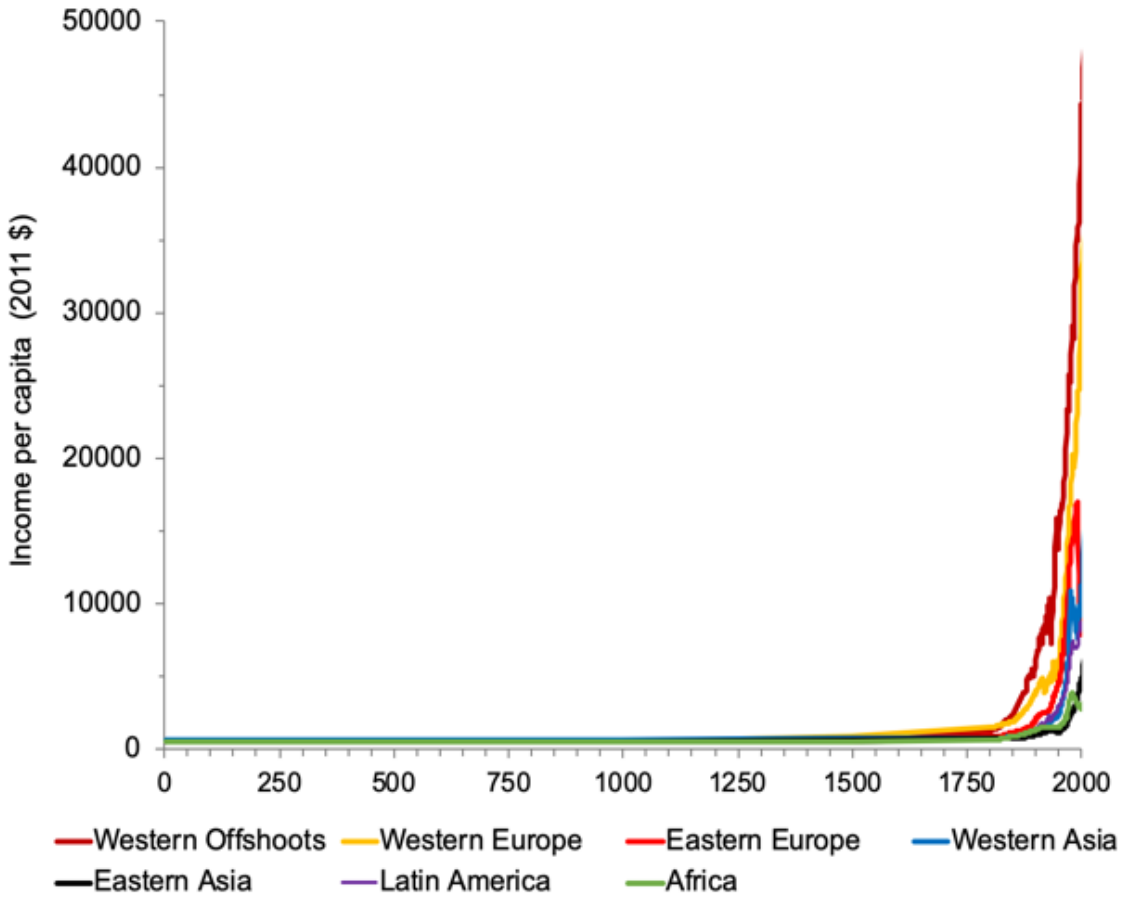
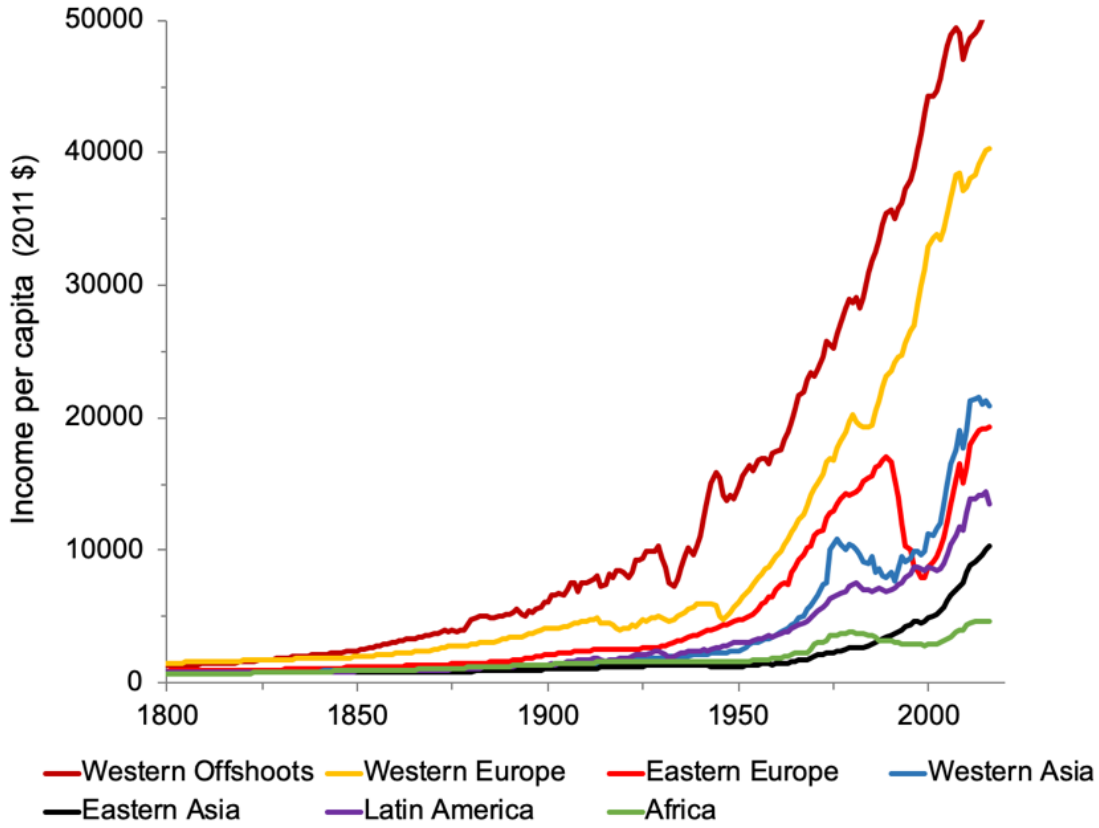
- The Mystery of Inequality
  - What is the origin of the vast inequality in income per capita across countries and regions?

Dramatic Increase in Income per Capita in the Past 200 Years



Data Source: Maddison Project (2020)

Regional Divergence in Income Per Capita: 1800–2020



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Evidence

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  - The timing of the transition from stagnation to growth
  - The vast inequality across countries and regions
- The forces that triggered the onset of the demographic transition
  - Central to the resolution of the mysteries of growth & inequality

Phases of Development

- The Malthusian Epoch

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- The Post-Malthusian Regime

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- The Modern Growth Regime

Phases of Development: Timeline in the Most Developed Economies

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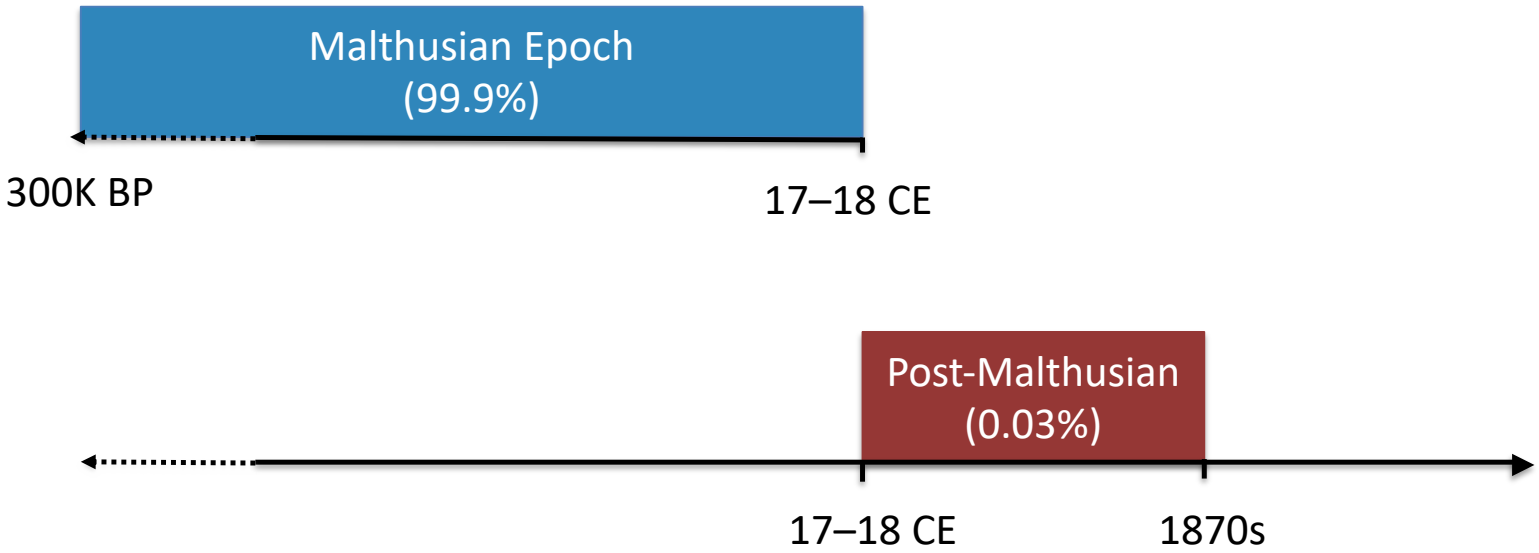

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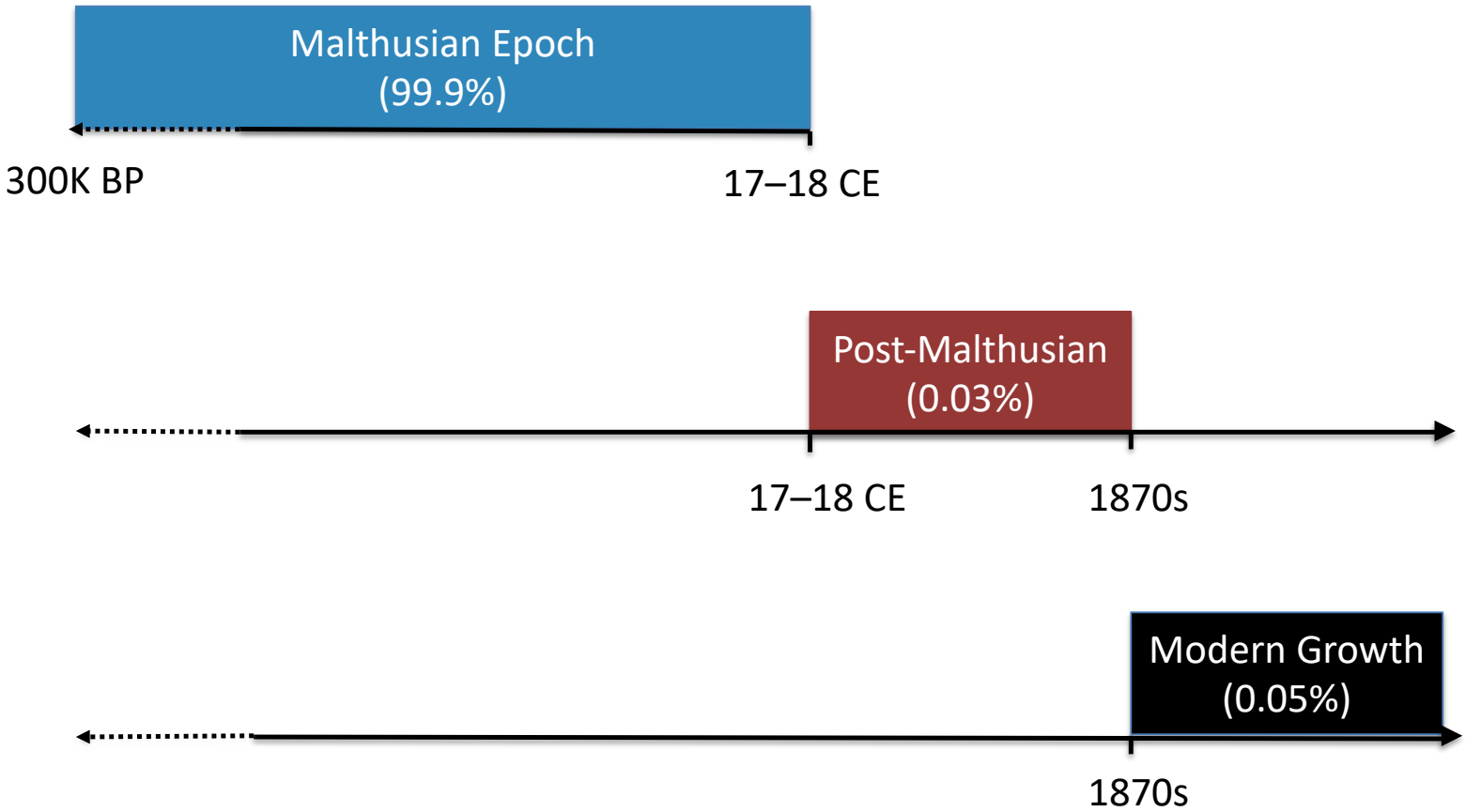

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  - Fertility, mortality & population growth decline very rapidly
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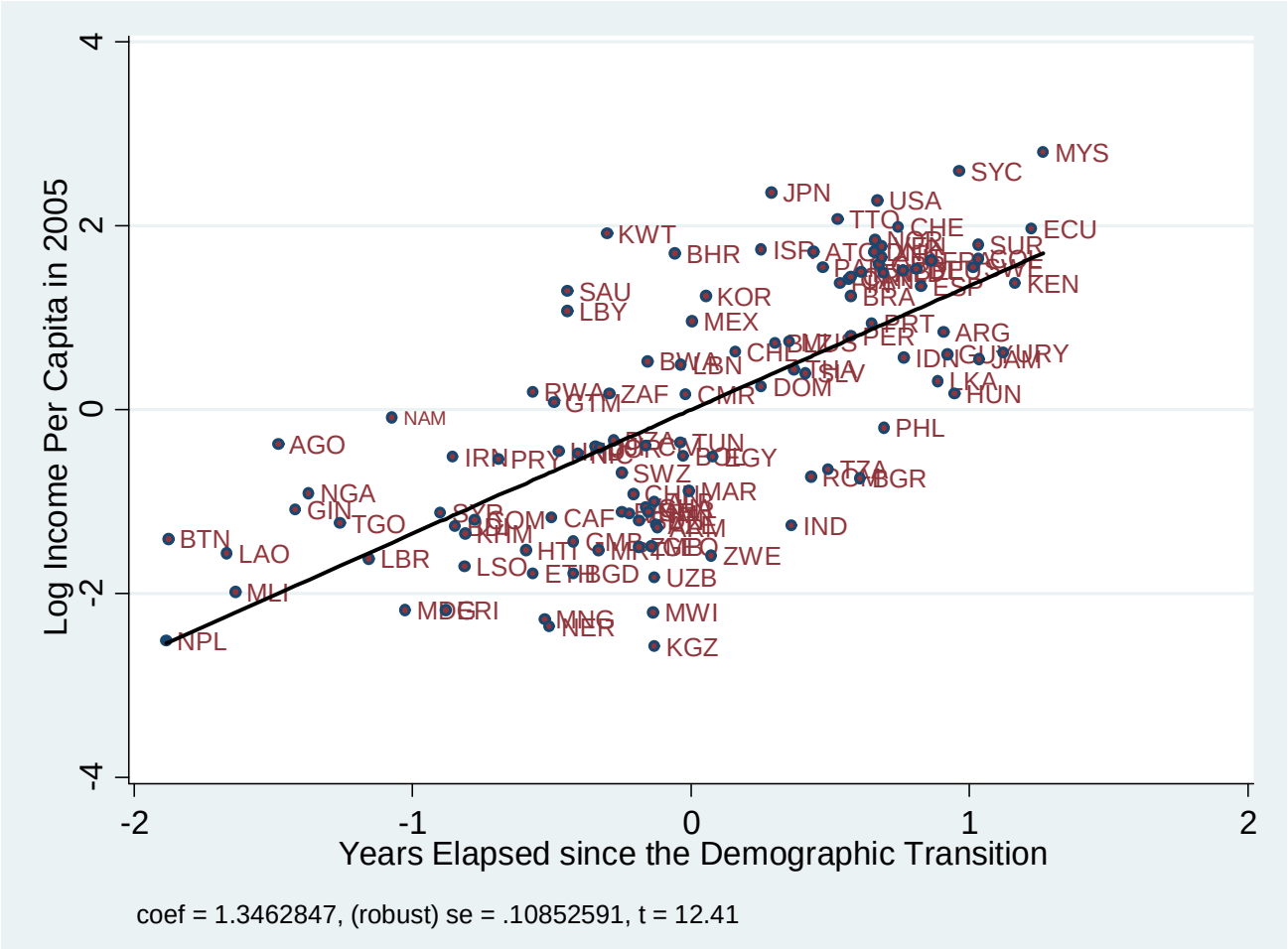
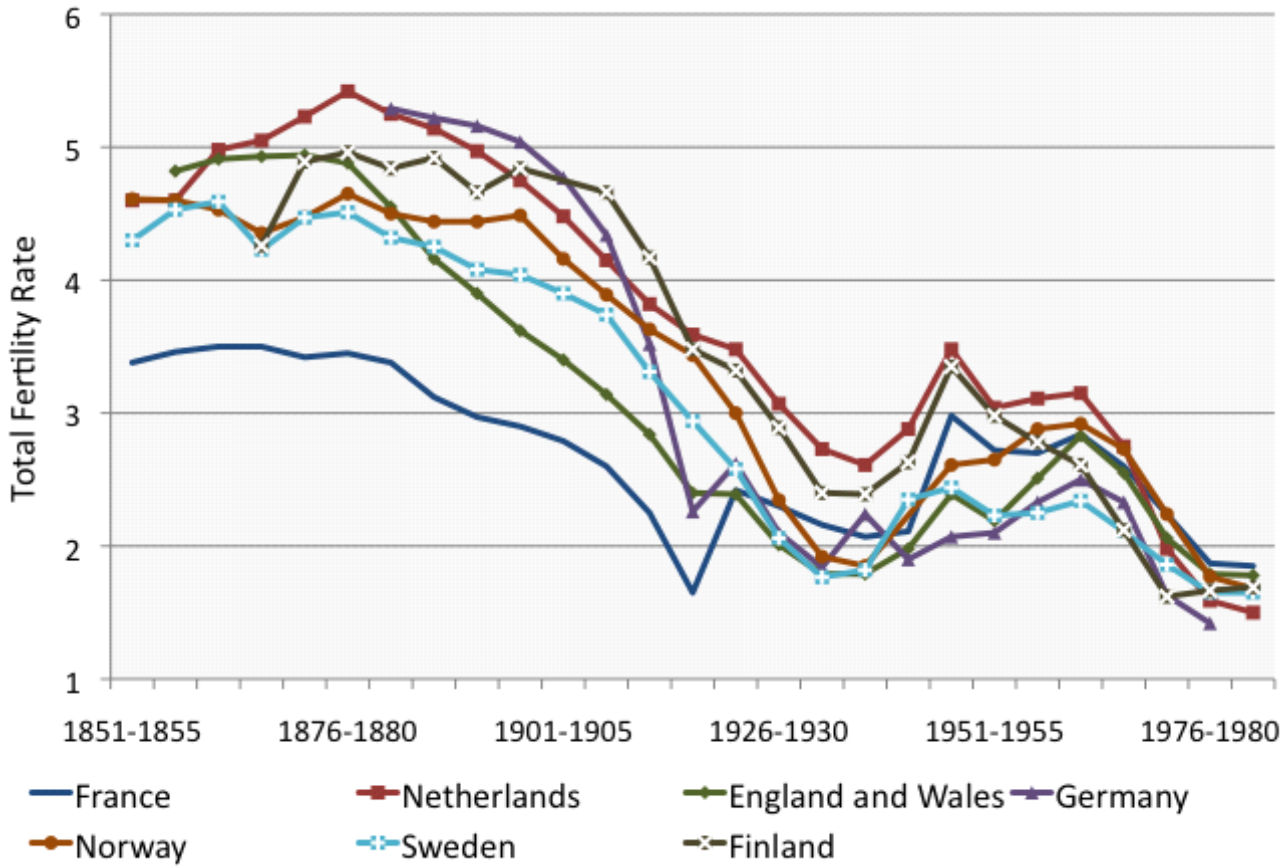
  - Freed the growth process from the counterbalancing effect of population
  - $\rightarrow$ Transition to Modern Growth

Timing of the Demographic Transition and Current Income per Capita

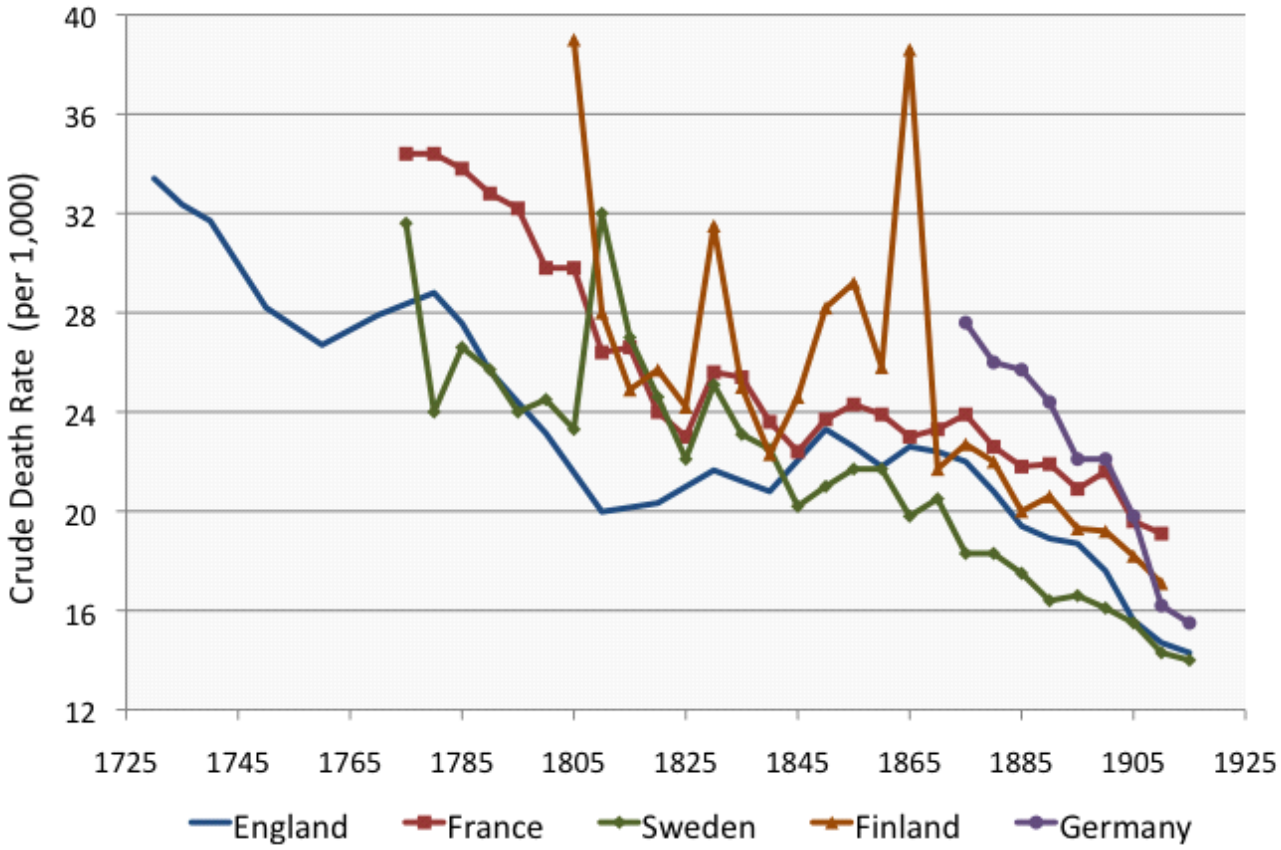


coef = 1.3462847, (robust) se = .10852591, t = 12.41

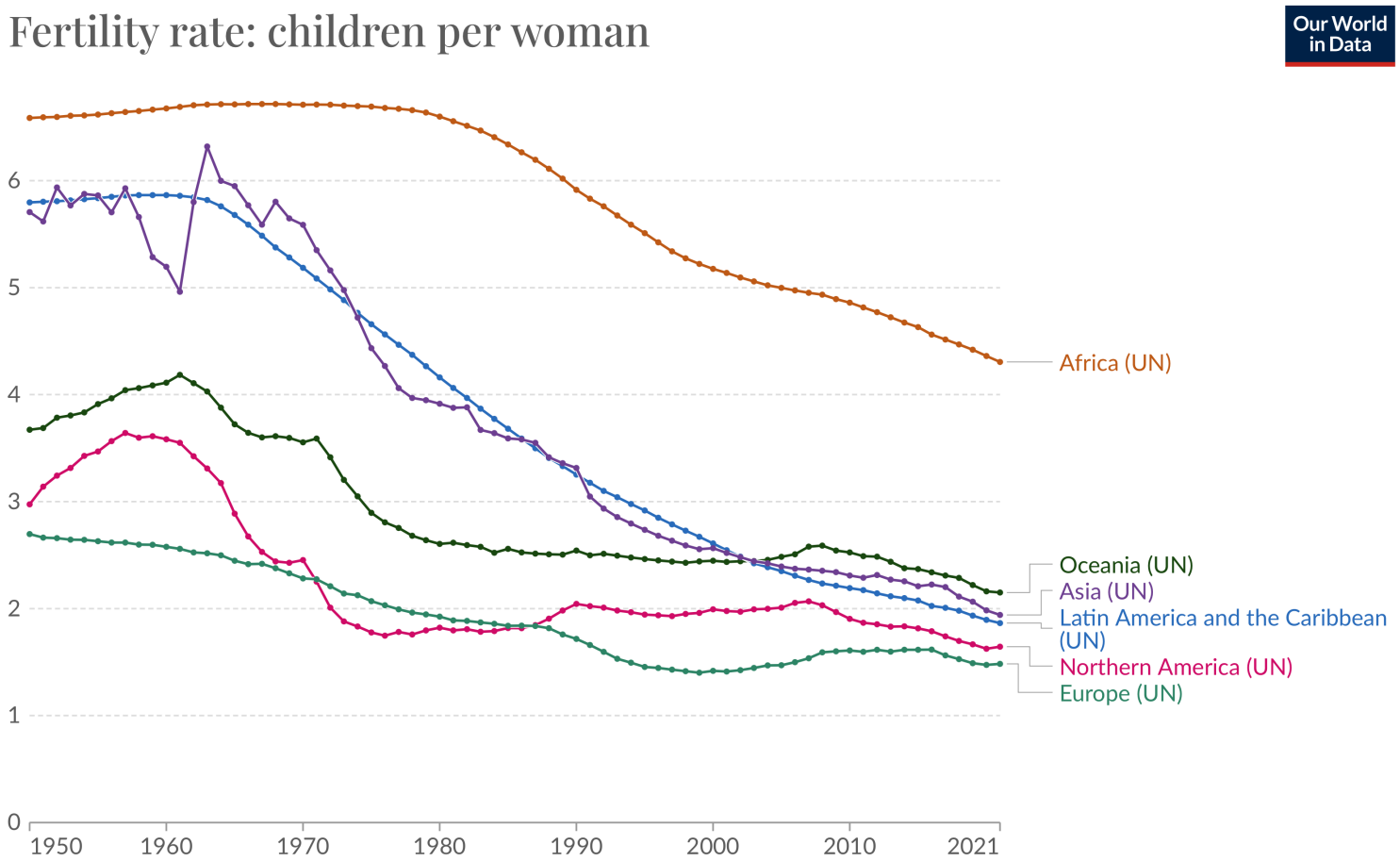
The Demographic Transition in Western Europe: Total Fertility Rates



Mortality Decline Western Europe: 1730-1920



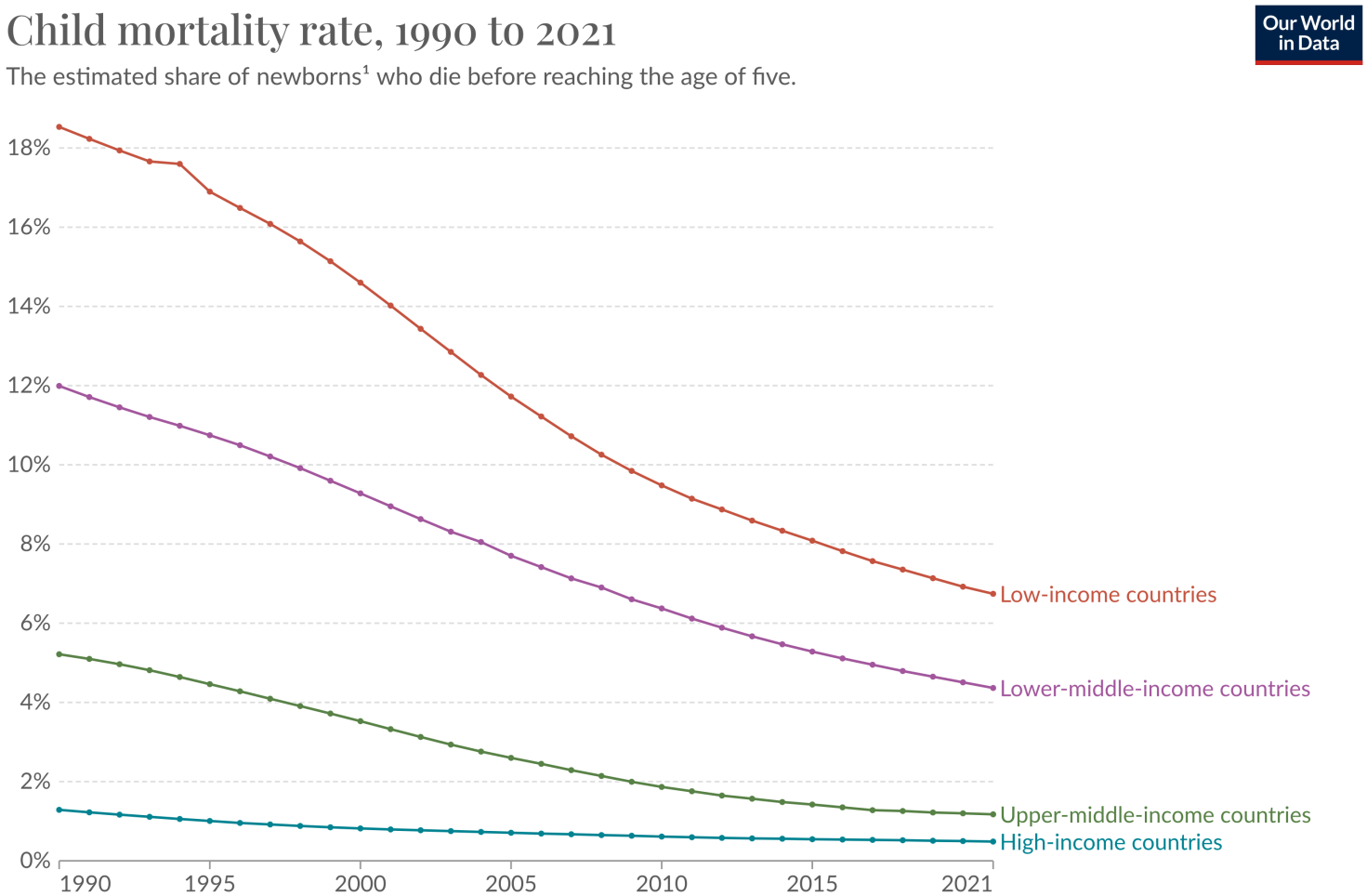
Total Fertility Rate Across Regions, 1950-2021



Data source: United Nations, World Population Prospects (2022) OurWorldInData.org/fertility-rate | CC BY

Note: The total fertility rate is the number of children born to a woman if she were to live to the end of her childbearing years and give birth to children at the current age-specific fertility rates.

Child Mortality Rates Across Income Groups, 1990-2021



1. Newborn: A newborn is defined as a baby born alive, and usually refers to neonates – under 28 days old. Read more in our article: How do statistical organizations define age periods for children?

Theories of the Demographic Transition

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- Household's Budget constraint

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$$c \leq y - y\tau n = y(1 - \tau n)$$

  - $1 \equiv$ household's time endowment

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- Preference-based theory
  - Assumes innate bias against child quantity beyond a certain level of income
- Non-robust
  - Different preferences will generate qualitatively different results
    - Homothetic preferences: a rise in income will NOT trigger fertility decline

The Rise in Income - Homothetic Preferences

- Preferences:

$$U = n^{\gamma} c^{(1-\gamma)} \qquad 0 < \gamma < 1$$

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$$y\tau n = \gamma y$$
$$c = (1-\gamma)y$$

The Rise in Income - Homothetic Preferences

- Optimal number of children $[y\tau n = \gamma y]$

$$n = \gamma/\tau$$

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- Optimal number of children $[y\tau n = \gamma y]$

$$n = \gamma/\tau$$

- $\Rightarrow$ Income has no effect on fertility, i.e.,

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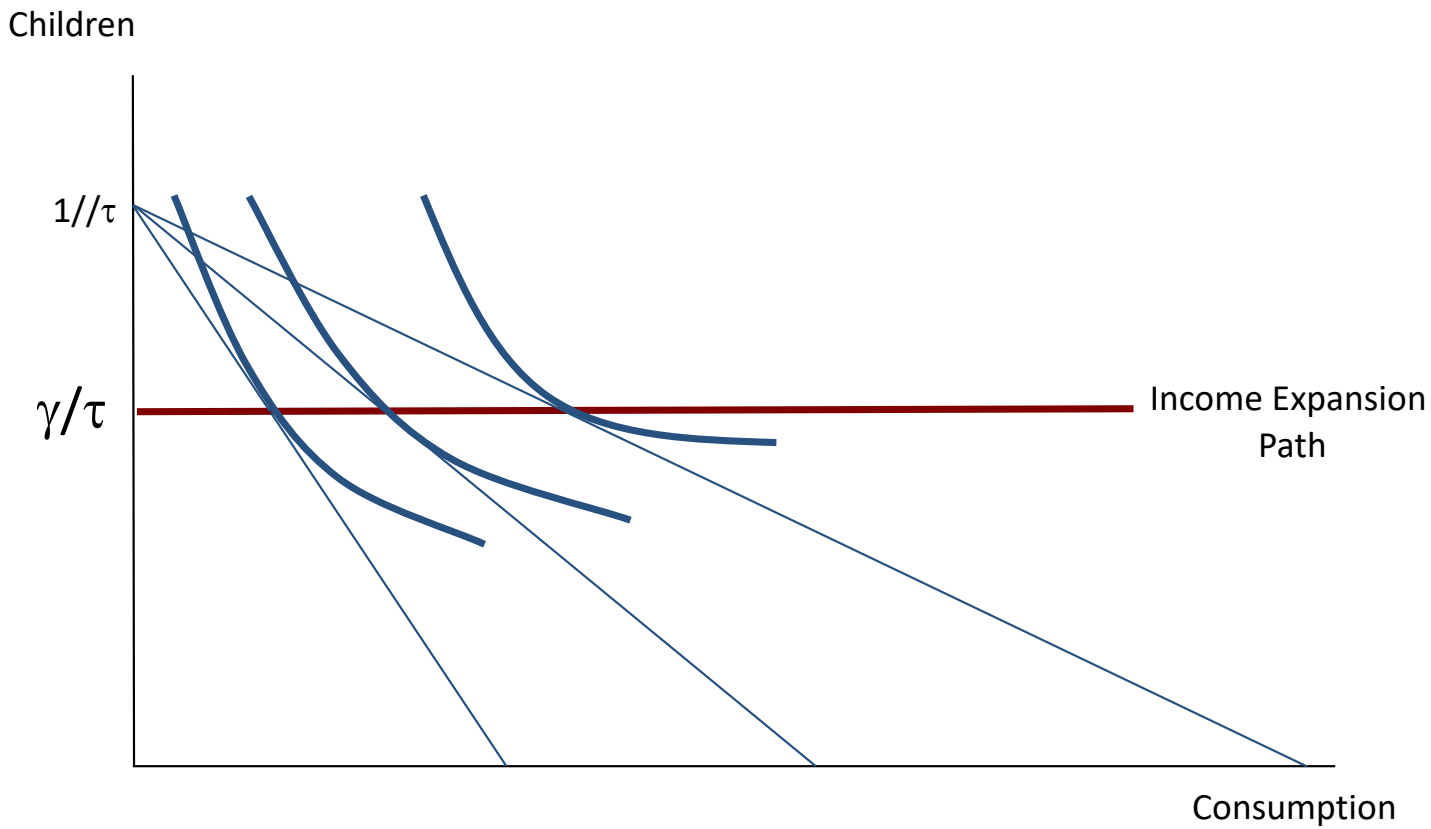
- Fertility is unaffected by the rise in income

The Rise in Income - Homothetic Preferences



- $1 =$ Household's time endowment
- $\gamma =$ The optimal time devoted to children ($\gamma/\tau =$ optimal number of children)
  - $\Rightarrow$ number of children is independent of the level of income

The Rise in Income: Testable predictions

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The Rise in Income: Refuting Cross Country Evidence

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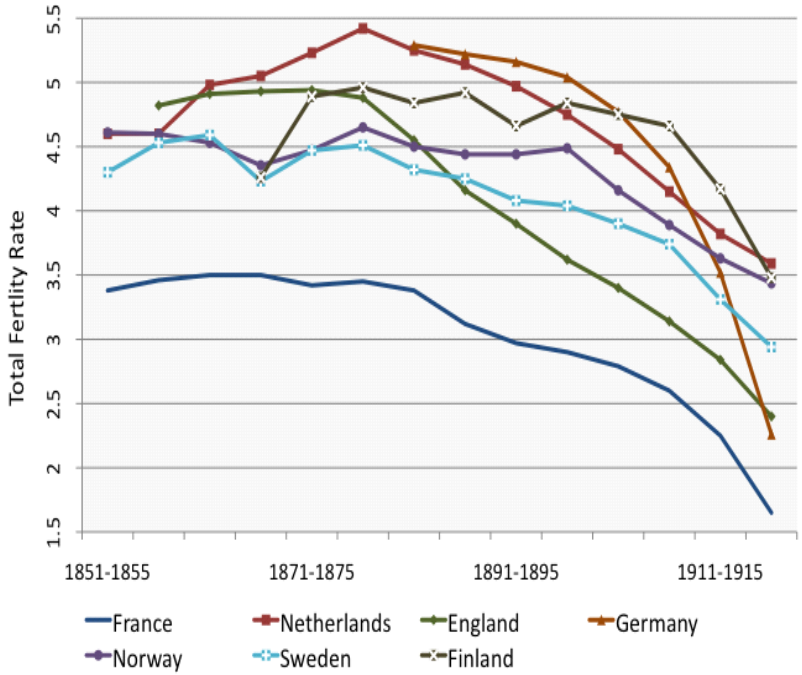
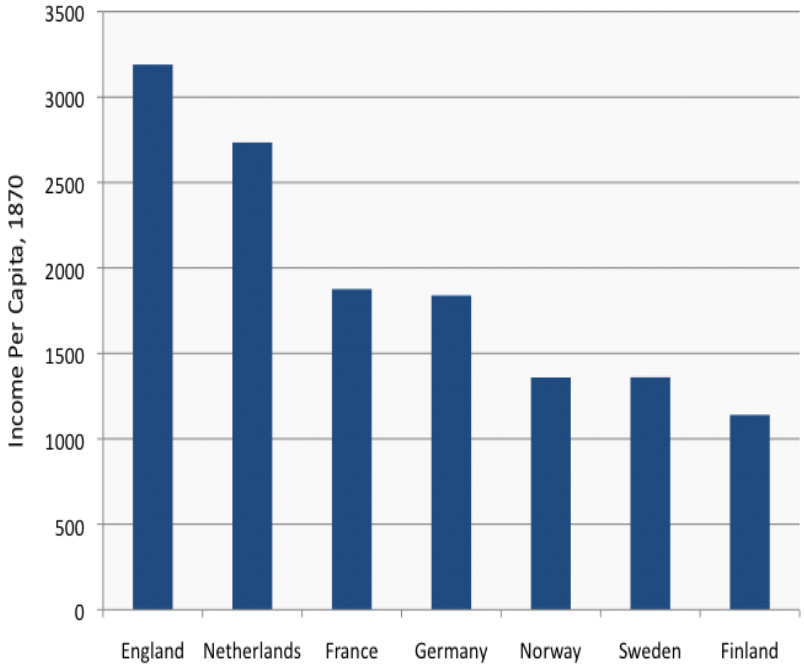
Simultaneous DT despite large gaps in income: W. Europe in the 1870s





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- England (pre-industrialization)
  - Reproductive success increases with income (Clark (JEH 2006, De la Croix et al.,, JEG 2019)

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$$c = (1-\gamma)y$$

- Optimal number of surviving children (NRR - Net Reproduction Rate)

$$n = \gamma/\tau$$

- Optimal number of children born (TFR - Total Fertility Rate)

$$n^b = \frac{n}{(1-\theta)} = \frac{\gamma}{(1-\theta)\tau}$$

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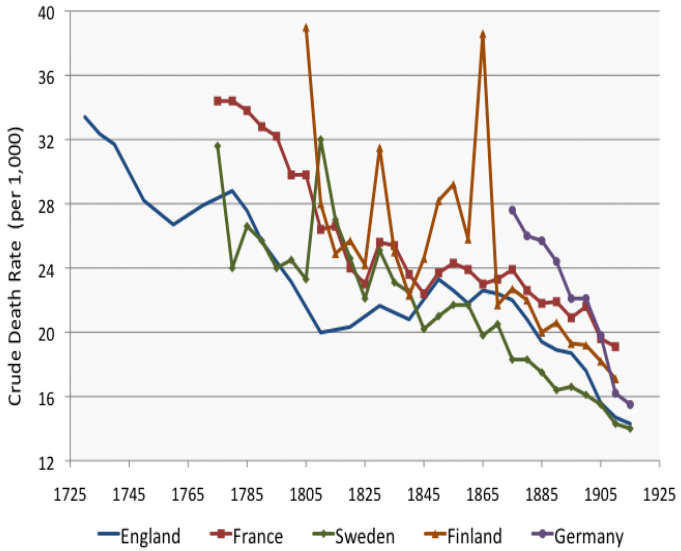
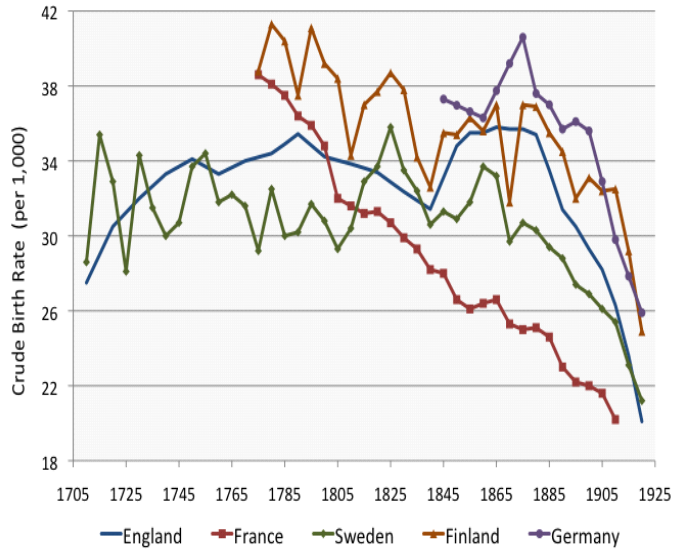
The Decline in Mortality and Fertility (TFR) - Evidence





The Decline in Child Mortality – Challenges

- Worldwide
  - NRR and TFR plummet jointly during the demographic transition
    - Yet, the basic theory $\Rightarrow$ NO decline in NRR
- NRR would decline if:
  - There exists a precautionary demand for children
    - Highly plausible
  - RA with respect to fertility $>$ RA with respect to consumption
    - Yet, evolutionary theory $\Rightarrow$ RA with respect to n $<$ RA with respect to c
  - Replacement fertility is insignificant
    - Yet, replacement fertility is sizable ranging from 0.2–0.6)
  - Resources saved from investment in non-surviving children are not channeled towards higher fertility

The Decline in Child Mortality – Challenging Anecdotal Evidence

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- France, USA & Some LDCs:
  - The decline in mortality did NOT precede the decline in fertility
- Western Europe
  - No change in the patterns of mortality decline at the time of the sharp decline in fertility
- England:
  - The decline in mortality started in England in the 1720s (150 years before the fertility decline) and was accompanied by a rise in fertility rates til 1800

The Decline in Mortality: Refuting Evidence from Individual Countries

- France (1876–96):
  - Mortality rate had no effect on fertility during France's demographic transition, accounting for education, income, and the gender literacy gap. (Murphy JOEG 2015)
- England (1861–1951):
  - The force associated with the decline in child mortality would have led to an increase in fertility rates (Fernandez Villaverde, 2001; Doepke, J.Pop.E 2005)

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    - Yet in fact they had more children

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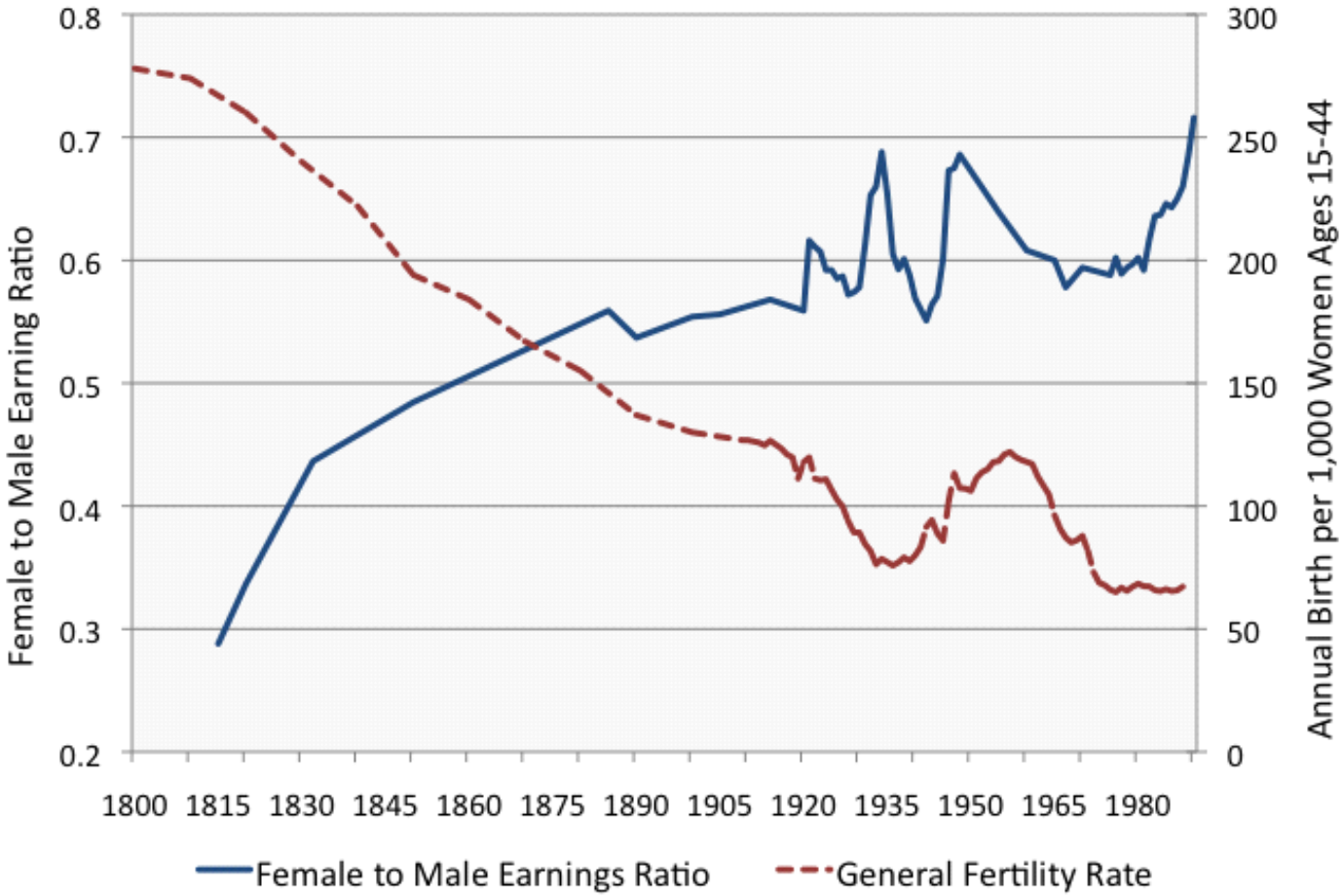
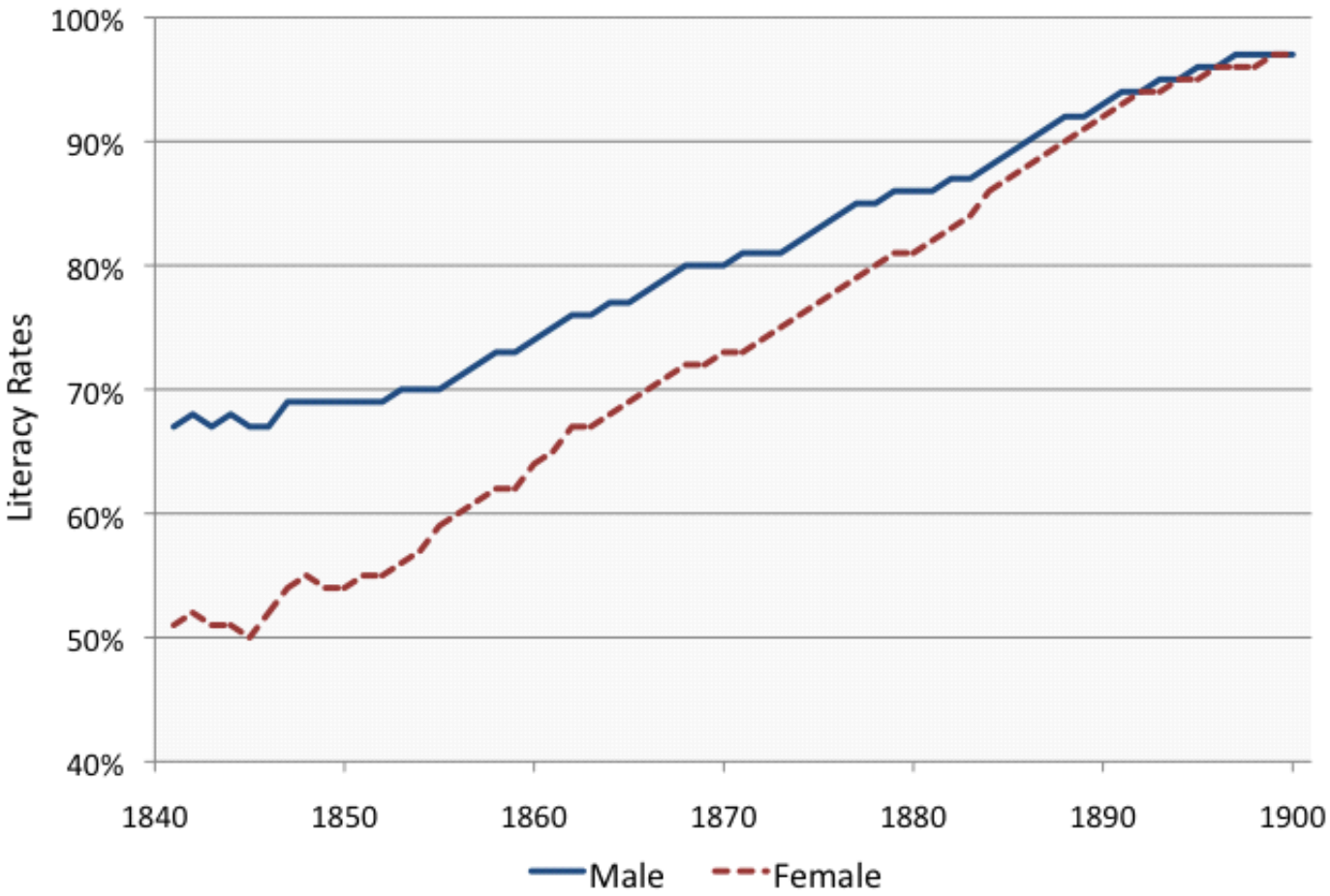
Mechanism: I. Development and Women's Wages

- Female-Biased technical change
  - Mechanization & advanced technologies have complemented mental tasks more than physical tasks
  - Women have physiological comparative advantage in mental (rather than physical) tasks
- The process of development has increased the productivity of women relative to men:
  - Economic Development $\rightarrow \quad (w^F / w^M) \Uparrow$
  - $w^F \equiv$ women's wages
  - $w^M \equiv$ men's wages

Evolution of the Gender Earning Ratio - US



Evolution of the Gender Literacy Gap - England



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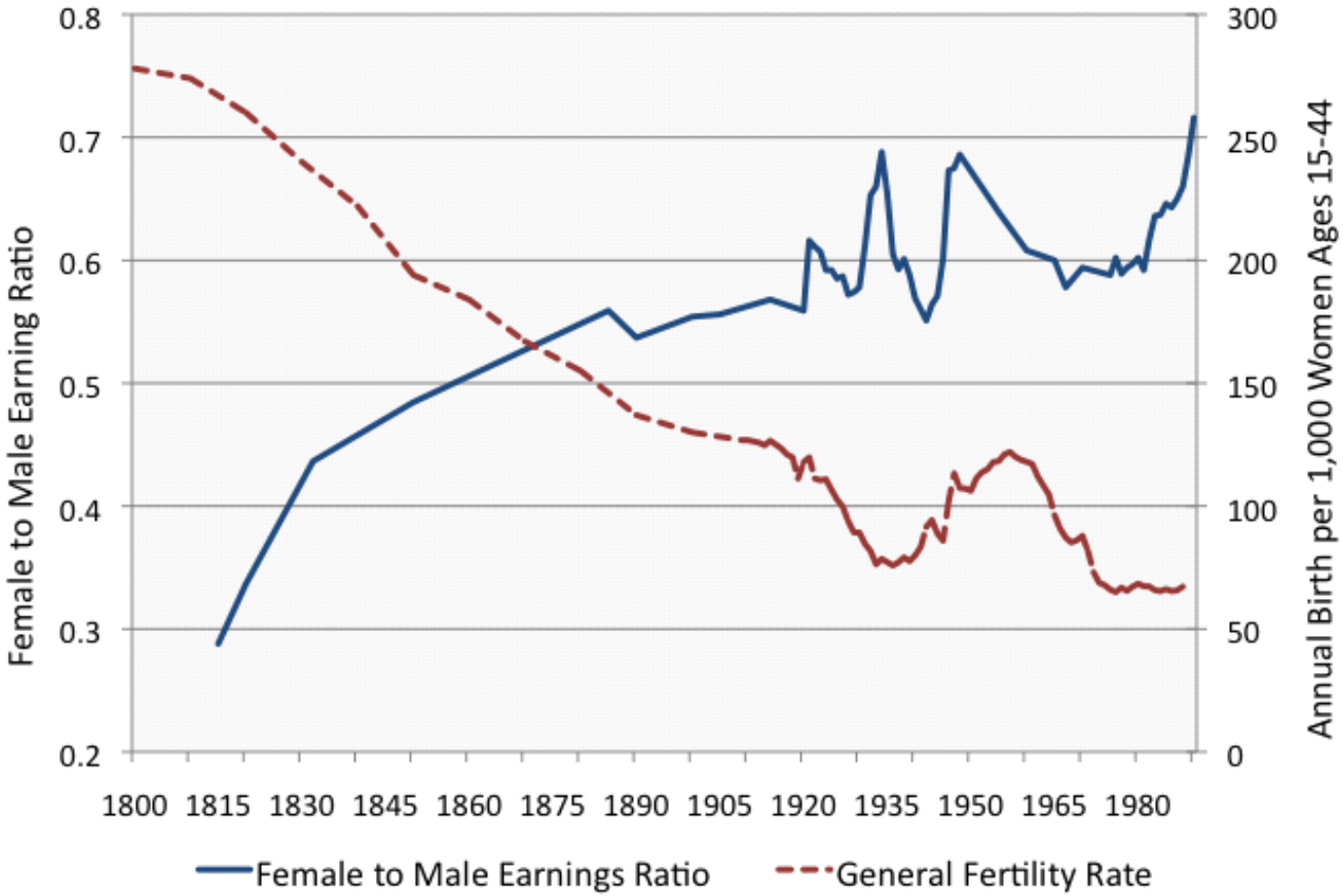

Women's Relative Wages and Fertility - Evidence

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- Sweden (19th century)
  - $(w^F/w^M) \Uparrow \implies n \Downarrow$

    Schultz (1985)

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    Schultz (1985)
- France (1876–1896):
  - Reduction in the gender literacy gap had an adverse effect on fertility, accounting for income per capita, educational attainment, and mortality rates (Murphy JOEG 2015)

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  - Basic level of human capital & interior solution

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- The cost of raising a child (regardless of quality) increases
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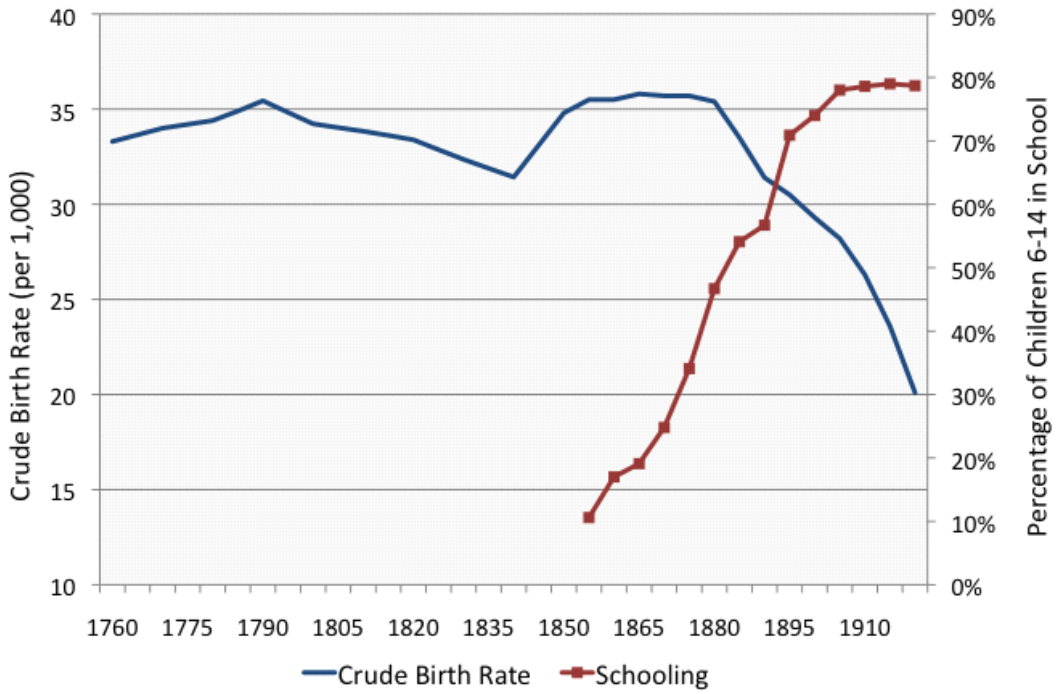
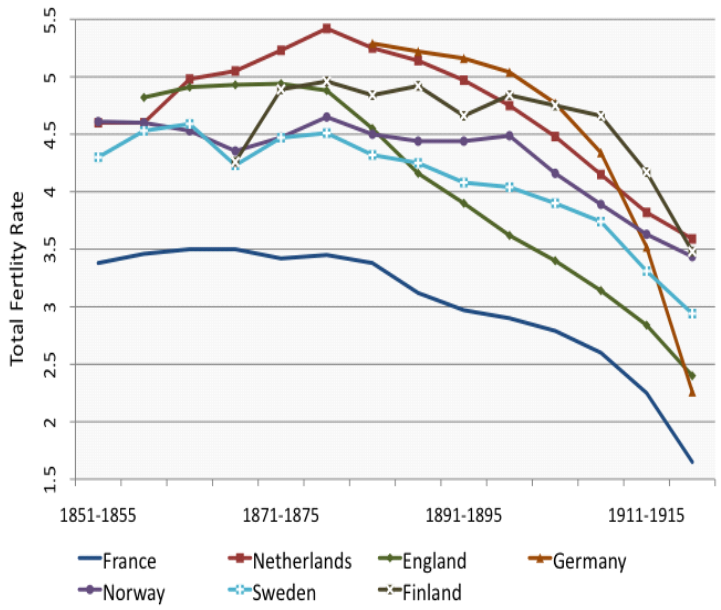
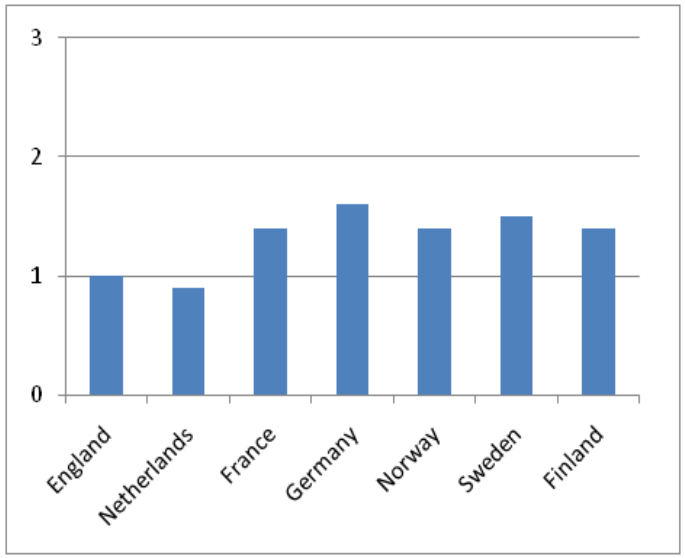
- The cost of educating a child increases and the elasticity of child quality with respect to the cost of child quality is smaller than one in absolute value
$$\partial n/\partial \tau^e < 0 \text{ if } [\partial e/\partial \tau^e][\tau^e/e] > -1$$

Human Capital Formation and the Fertility Decline - England



Growth Rates 1870-1913 and DT





Supporting Evidence

- US (1880-1910):
  - The rise in the return to child quality $\Rightarrow$ fertility decline
    - Variation in the extent of the eradication of hookworm (1910s) across the US South (Bleakley-Lange, RESTAT 2009)

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- Prussia (19th century):
  - The rise in human capital formation $\Rightarrow$ fertility decline
    - IV: variation in land concentration
    - IV: Distance from the birthplace of Protestantism - Wittenberg (Becker-Cinnirella-Woessmann, JOEG 2010)

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- England (1580-1871)
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- China (13th-20th century)
  - An increase the return to human capital $\Rightarrow$ fertility decline
    - Changes in the civil service examination system overtime

    (Shiue, JOEG 2017)
- Ireland (1911)
  - Adverse effect of education attainment on fertility rates

    (Fernihough, JOEG 2017)

Appendix - Optimization

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$$\begin{aligned} \{n, e, c\} = \arg\max \; & \gamma[\ln n + \beta \ln h(e, g)] + (1-\gamma)\ln c \\ s.t. \quad & yn(\tau^q + \tau^e e) + c \leq y \end{aligned}$$

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$$n(\tau^q + \tau^e e) = \gamma$$

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$$\{n, e\} = \arg\max \gamma[\ln n + \beta \ln h(e, g)] + (1 - \gamma) \ln y[1 - n(\tau^q + \tau^e e)]$$

with respect to e :

$$\frac{\gamma\beta h_e(e, g)}{h(e, g)} = \frac{(1 - \gamma) y n \tau^e}{y[1 - n(\tau^q + \tau^e e)]}$$

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$$\frac{\gamma\beta h_e(e, g)}{h(e, g)} = n\tau^e \quad \Longrightarrow \quad \frac{\beta h_e(e, g)}{h(e, g)} = \frac{\tau^e}{(\tau^q + \tau^e e)}$$

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$$\{n, e\} = \arg\max \gamma[\ln n + \beta \ln h(e, g)] + (1 - \gamma) \ln y[1 - n(\tau^q + \tau^e e)]$$

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$$\frac{\gamma\beta h_e(e, g)}{h(e, g)} = n\tau^e \quad \Longrightarrow \quad \frac{\beta h_e(e, g)}{h(e, g)} = \frac{\tau^e}{(\tau^q + \tau^e e)}$$

$$\beta h_e(e, g)(\tau^q + \tau^e e) = \tau^e h(e, g)$$

Optimization

$$n = \gamma / (\tau^q + \tau^e e)$$

$$\tau^e h(e, g) = \beta h_e(e, g)(\tau^q + \tau^e e)$$

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$\Longrightarrow$

$$e = e(g, \beta, \tau^e, \tau^q),$$

$$n = \gamma / [\tau^q + \tau^e e(g, \beta, \tau^e, \tau^q)]$$

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