The Demographic Transition

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Economic Growth and Comparative Development

The Demographic Transition

A rapid decline in fertility, mortality and population growth that mark the transition to modern growth:

- The positive relationship between income per capita and population growth is reversed
- Gains in total output are not counterbalanced by population growth

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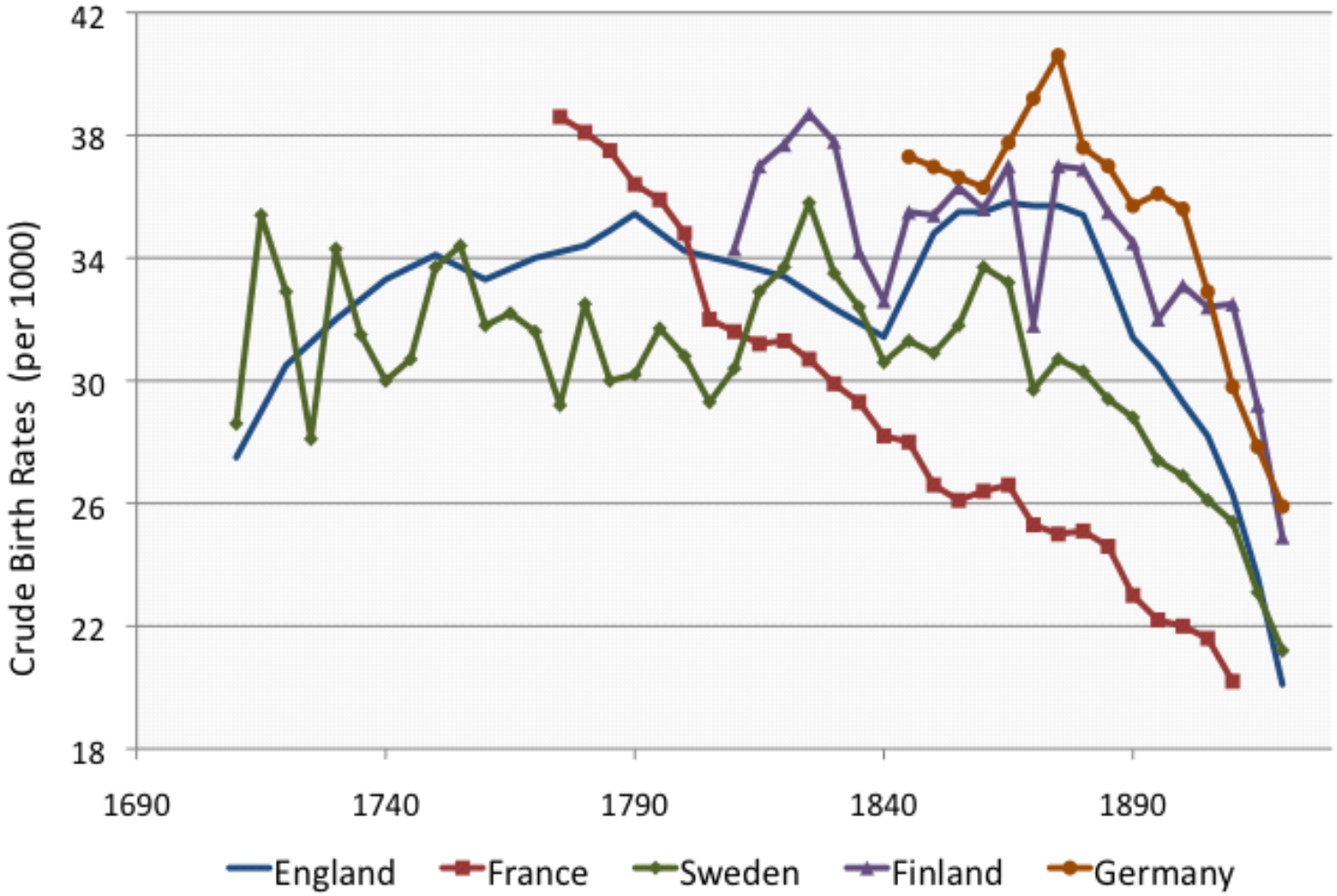
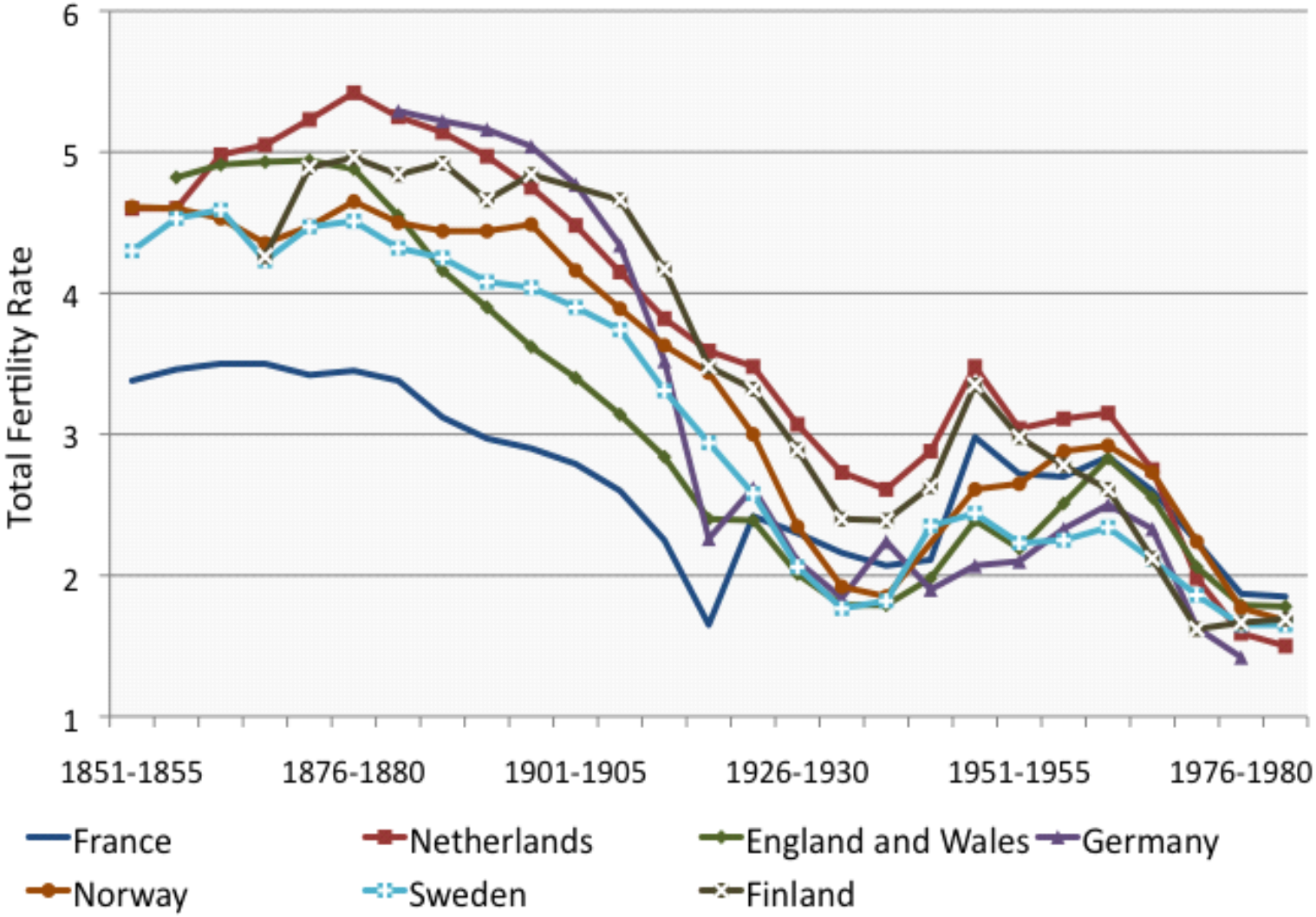
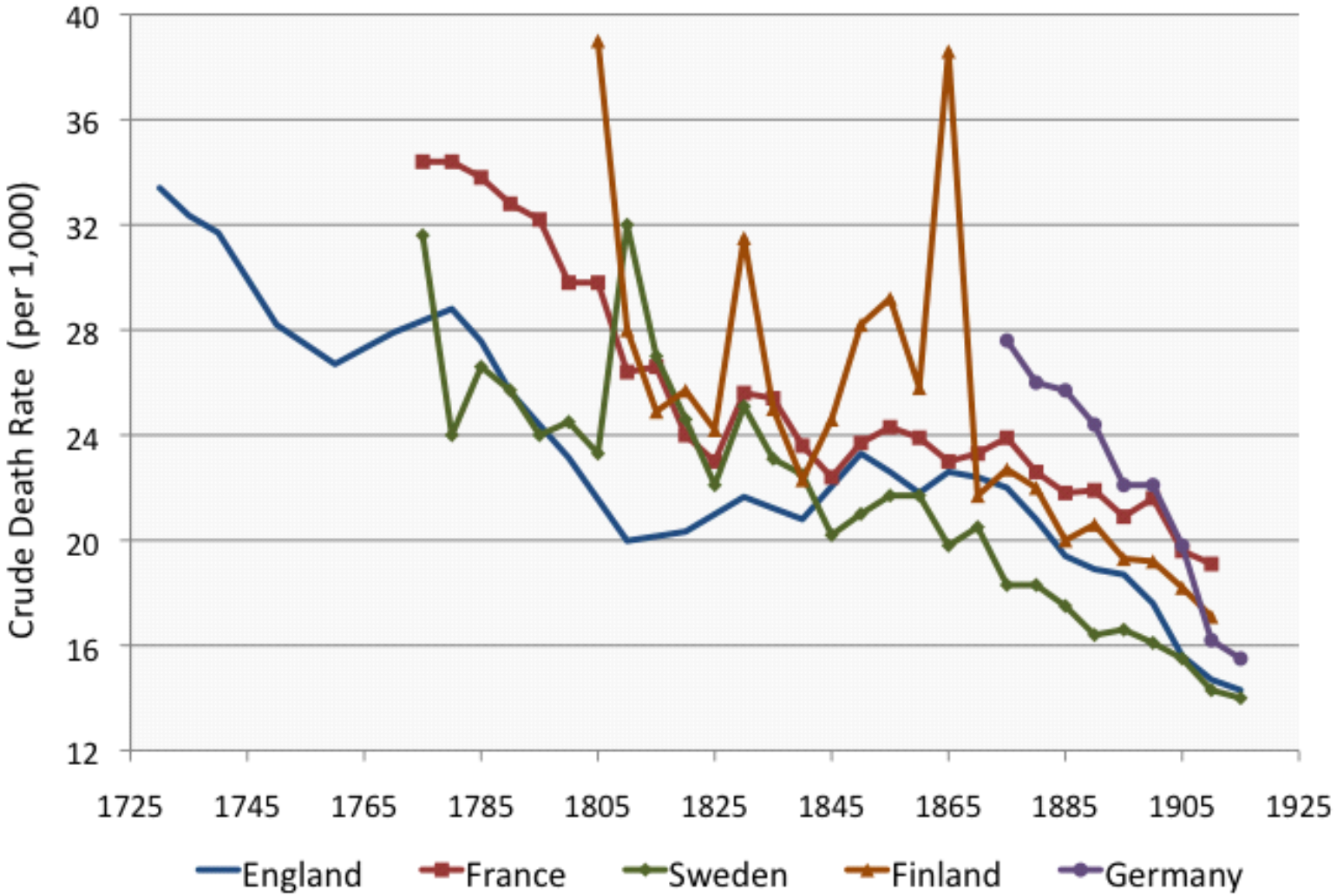
The Demographic Transition in Western Europe: Crude Birth Rates



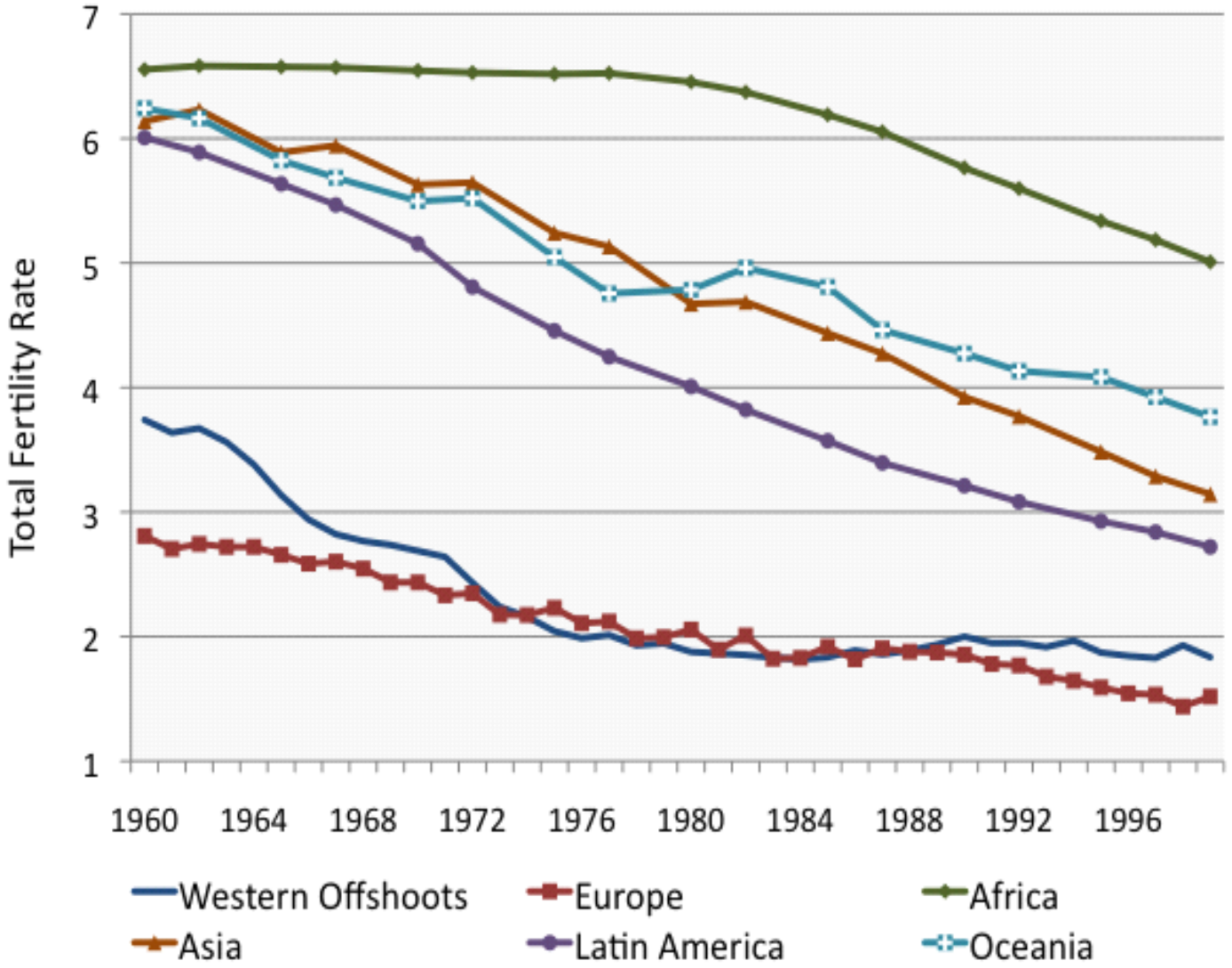
The Demographic Transition in Western Europe: Total Fertility Rates



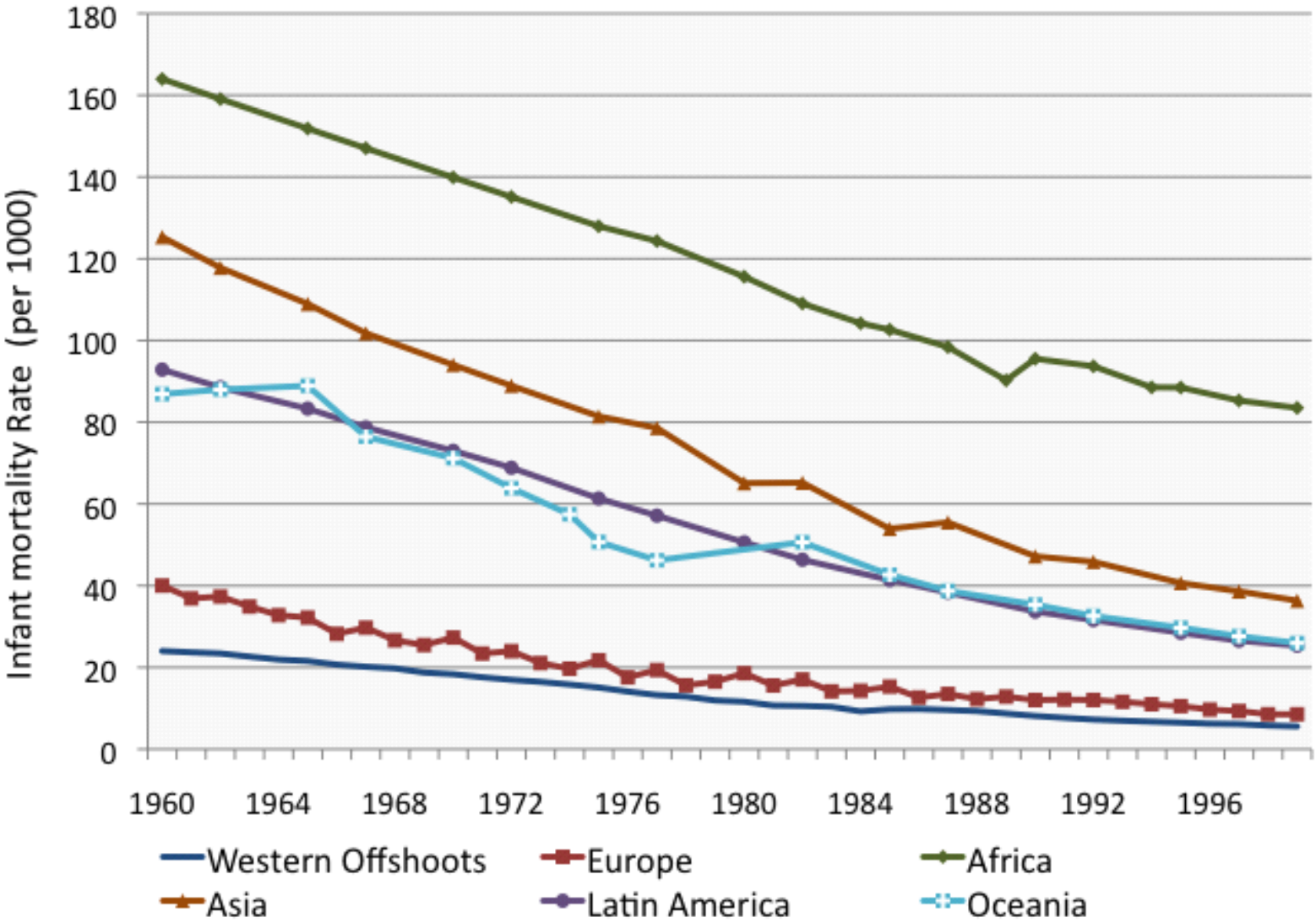
Mortality Decline Western Europe: 1730-1920



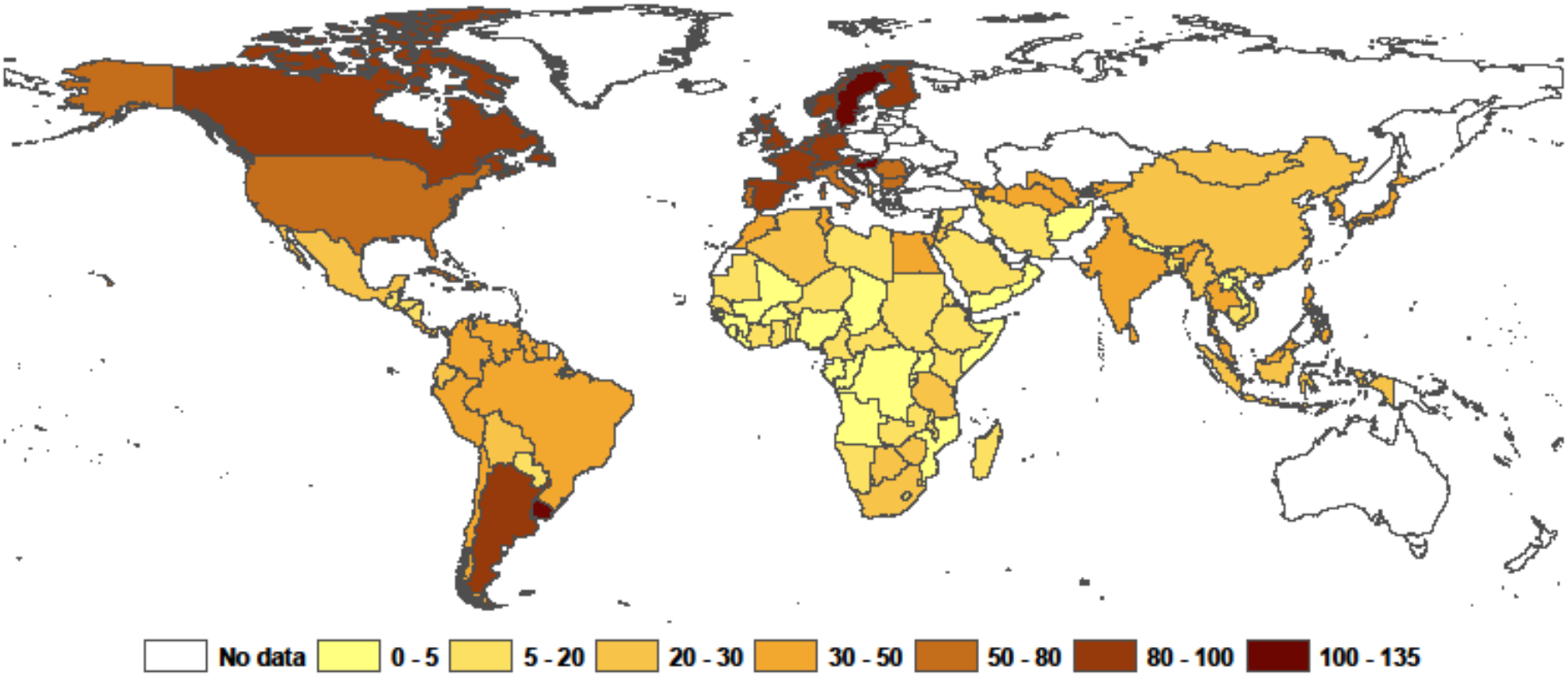
The Evolution of Total Fertility Rate across Regions, 1960-1999



Decline in infant mortality rates across regions, 1960-1999



Years Elapsed since the Demographic Transition



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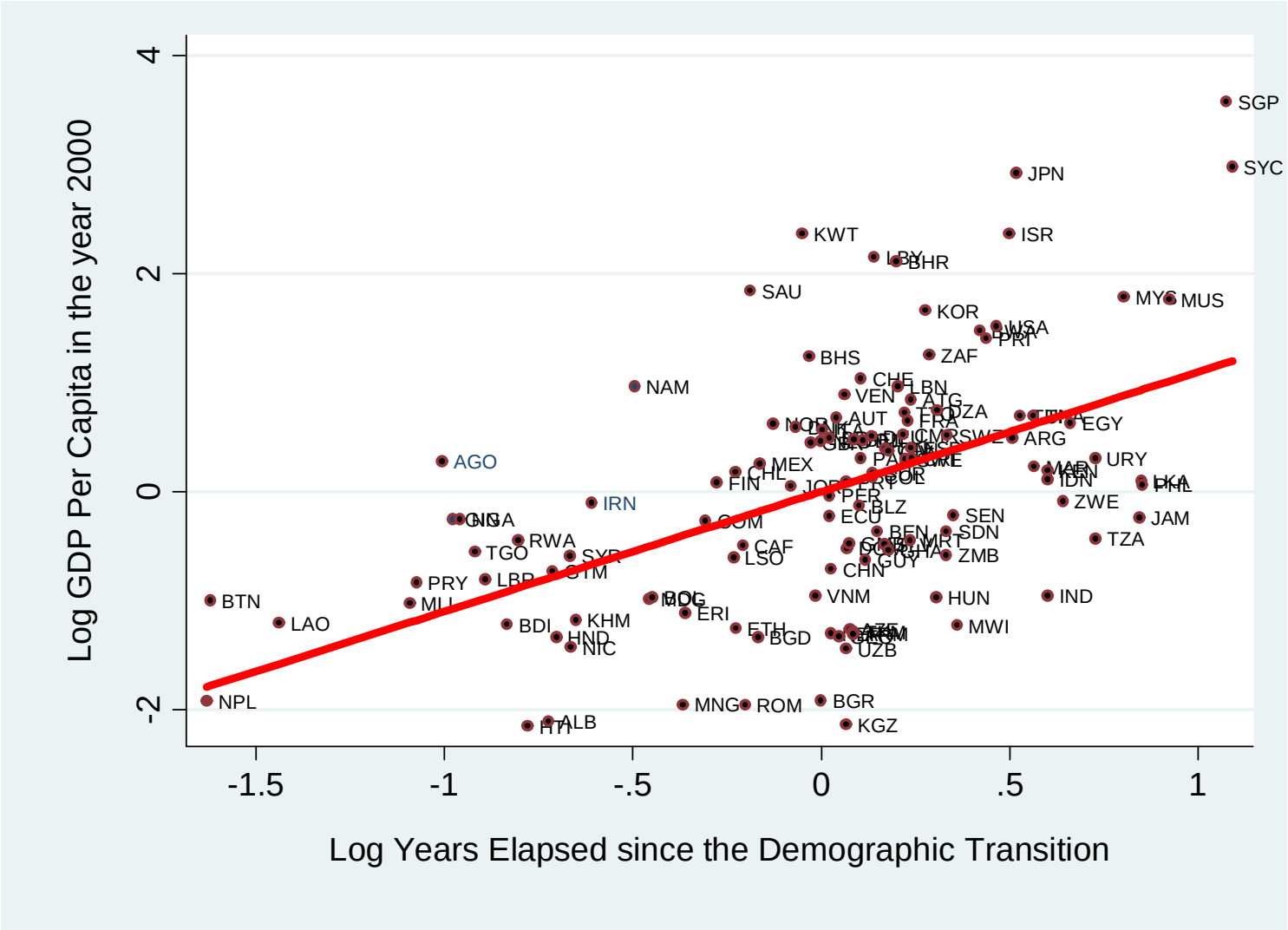
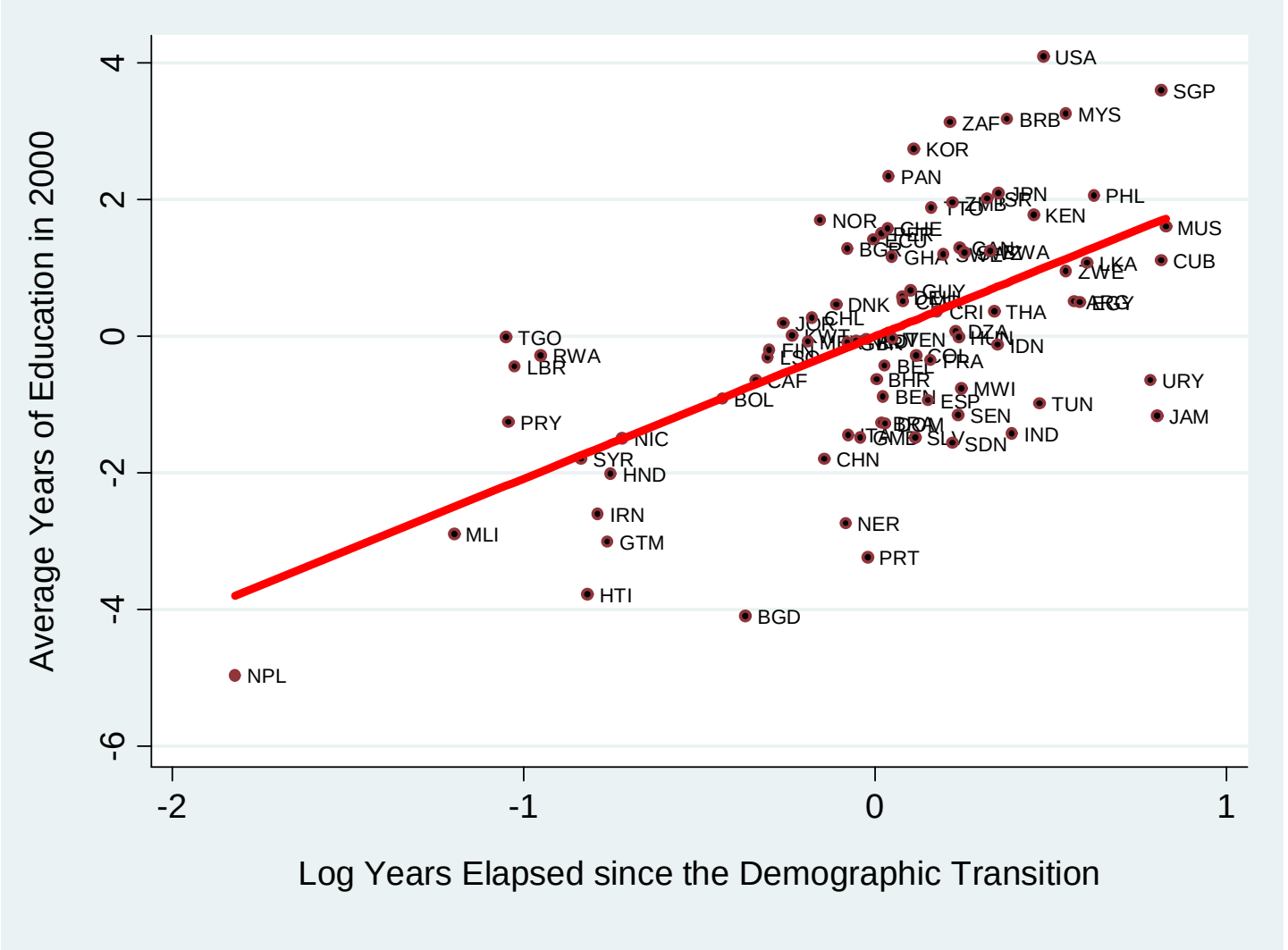


controlling for the absolute latitude and continental fixed effects

Years Elapsed since the Demographic Transition



controlling for the absolute latitude and continental fixed effects

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- The Rise in Income
  - The rise in income increased in the opportunity cost of raising children $\Rightarrow$ reduction in fertility (Becker, 1960)
  - The income elasticity of child quality is larger than that of child quantity $\Rightarrow$ substitution of child quality for quantity $\Rightarrow$ reduction in fertility (Becker and Lewis, JPE 1973)
- The Decline in Child Mortality
  - Mortality decline enabled families to attain the same number of children with lower fertility rates

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- The Old-Age Security Hypothesis (Caldwell, 1976)
  - Development of financial markets reduced the demand for children as an investment good

    $\Rightarrow$ reduction in fertility

- The Decline in the Gender Wage Gap (Galor-Weil, AER 1996))
  - The rise in the relative wages of women increases the opportunity cost of raising children more than family income

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  - Increased industrial demand for human capital induced human capital formation $\Rightarrow$ substitution of child quality for qunatity $\Rightarrow$ reduction in fertility $\Rightarrow$ (Galor-Weil, AER 1999, 2000)
    - Reinforced by: increased life expectancy
    - Reinforced by: decline in the profitability of child labor

      (Hazan-Berdugo, EJ 2002, Doepke-Zilibotti, AER 2005)
  - Evolution of preferences for child quality (Galor-Moav QJE, 2002)
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The Rise in Income: Mechanism

- Child rearing is time-intensive
- Budget constraint

$$y\tau n + c \leq y$$

  - $y \equiv$ household's income
  - $c \equiv$ household's consumption
  - $n \equiv$ household's (surviving) children
  - $\tau \equiv$ time cost per child
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The Rise in Income: Mechanism

- The rise in income generates two conflicting effects:
  - An income effect:

$$y\tau n + c \leq [y] \Uparrow$$

    - More income can be devoted to raising children
    - operates towards $n \Uparrow$

  - A substitution effect:

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- Fertility declines in the process of development

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- Preference-based theory (unattractive)
  - Innate bias against child quantity beyond a certain level of income - non-refutable
  - Non-robust (e.g., the class of homothetic preferences will not trigger a fertility decline)

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The Rise in Income - Homothetic Preferences

- Preferences:

$$u = \gamma \ln n + (1 - \gamma) \ln c$$

- Budget constraint

$$y\tau n + c \leq y$$

- Optimization: (fraction γ of income is spent on children and $(1 - \gamma)$ on consumption)

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

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The Rise in Income - Homothetic Preferences

- Optimal number of children

$$n = \gamma/\tau$$

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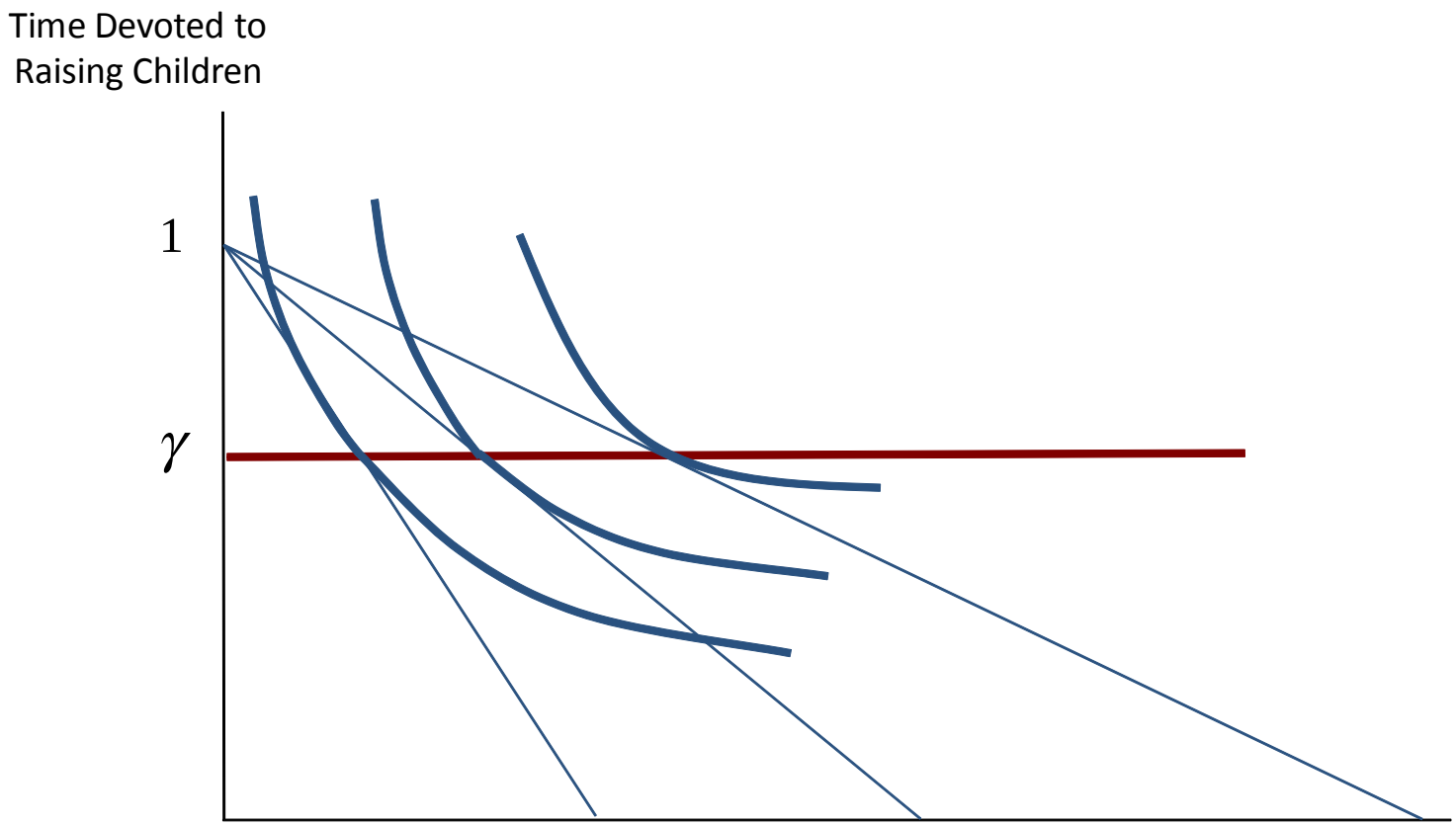

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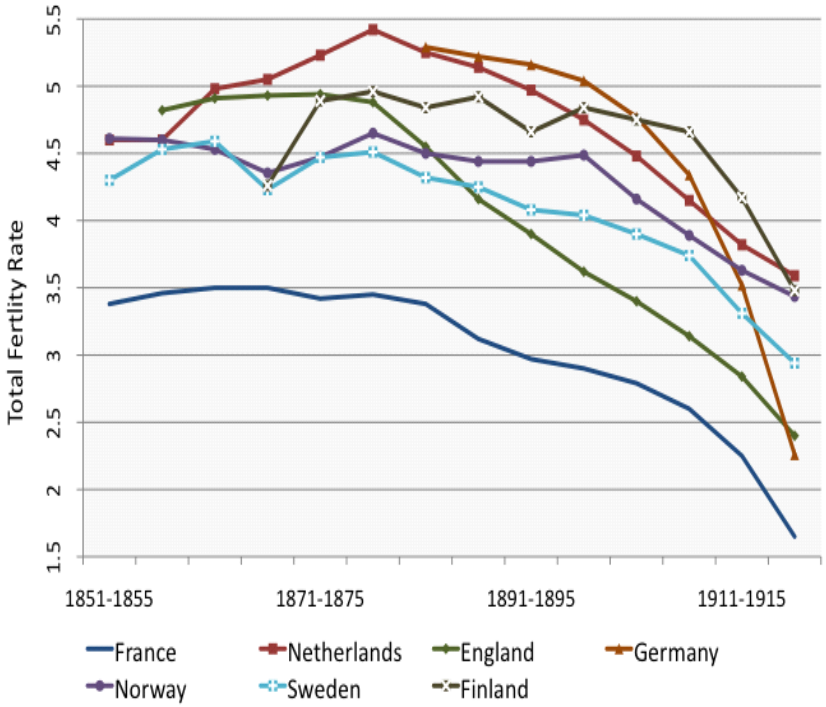
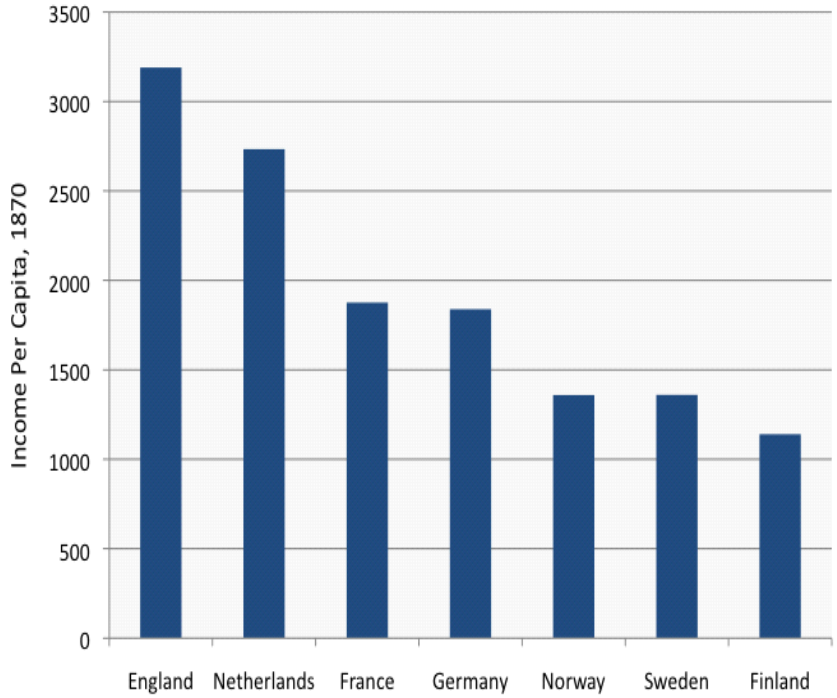
Simultaneous DT across European Countries that Differ in Income per Capita





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- A decline in child mortality permit parents to reach a given level of surviving children with lower fertility
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The Decline in Mortality – Mechanism

- Preferences:

$$u = \gamma \ln n + (1 - \gamma) \ln c$$

  - $c \equiv$ household's consumption
  - $n \equiv$ household's surviving children

- Survival children

$$n = \theta n^b$$

  - $\theta \equiv$ probability of a child to survive infancy
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- Optimization: (fraction γ of income is spent on children and $(1-\gamma)$ on consumption)

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NRR does not decline unless:

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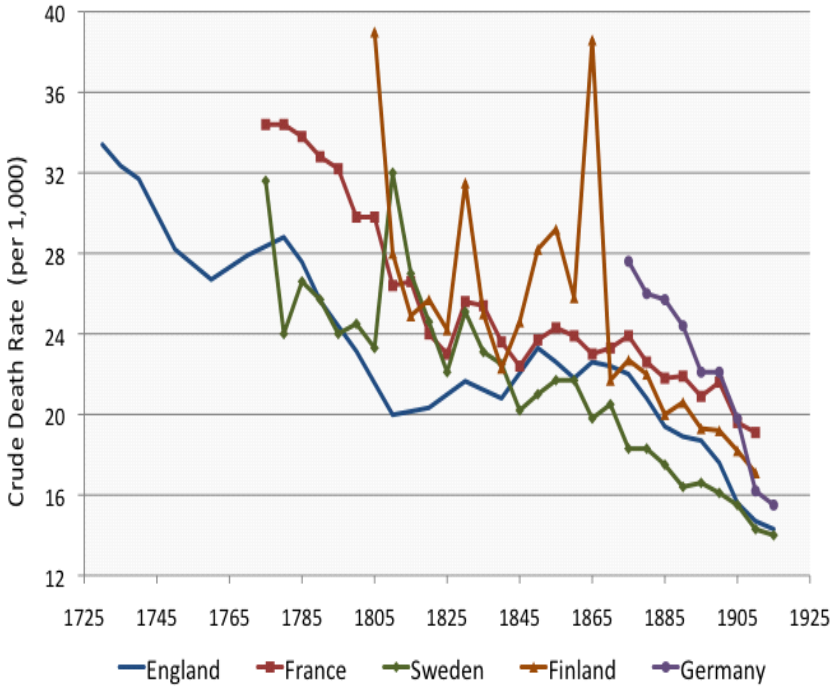
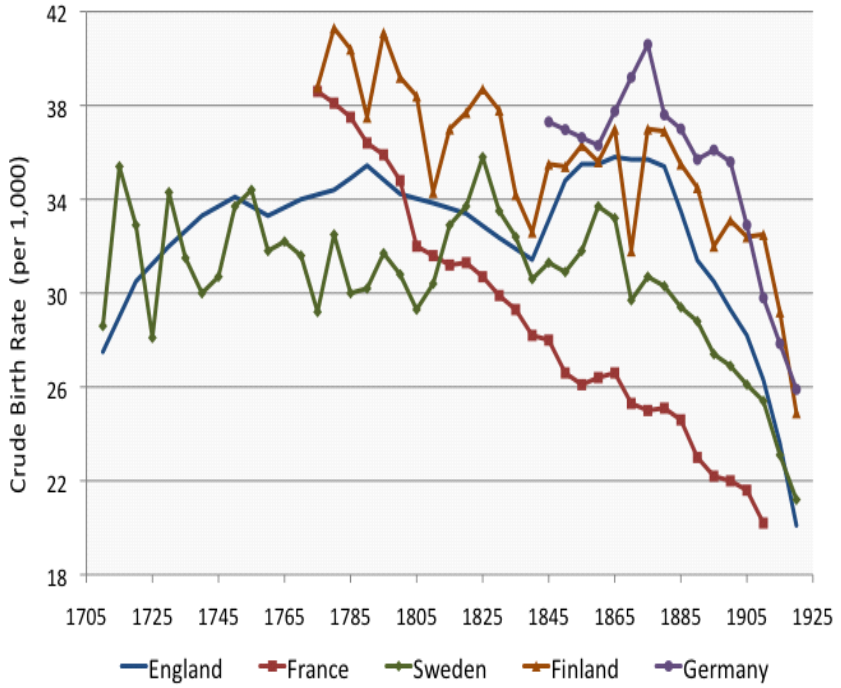
The Decline in Mortality and Fertility - Evidence





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- The decline in the importance of old-age support is unlikely to be a major force behind the significant reduction in fertility – at a rate of 30–50% – during the demographic transition:
  - Rare examples in nature of offspring that support their parents in old age
- Institutions supporting individuals in their old age were formed well before the demographic transition
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- Heterogeneity and Growth
  - Galor and Zeira (1993) – first attempt to explore the effect of heterogeneity, across households, and the growth process
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Mechanism: I. Development and Women's Wages

- Female-Biased Technical change
  - Mechanization and advanced technologies have complemented mental tasks more than physical tasks
  - Women have physiological comparative advantage in mental (rather than physical) tasks

$\Longrightarrow$ The process of development has (inevitably) increased the productivity of women relative to men:

$$k \Uparrow \Longrightarrow (w^F/w^M) \Uparrow$$

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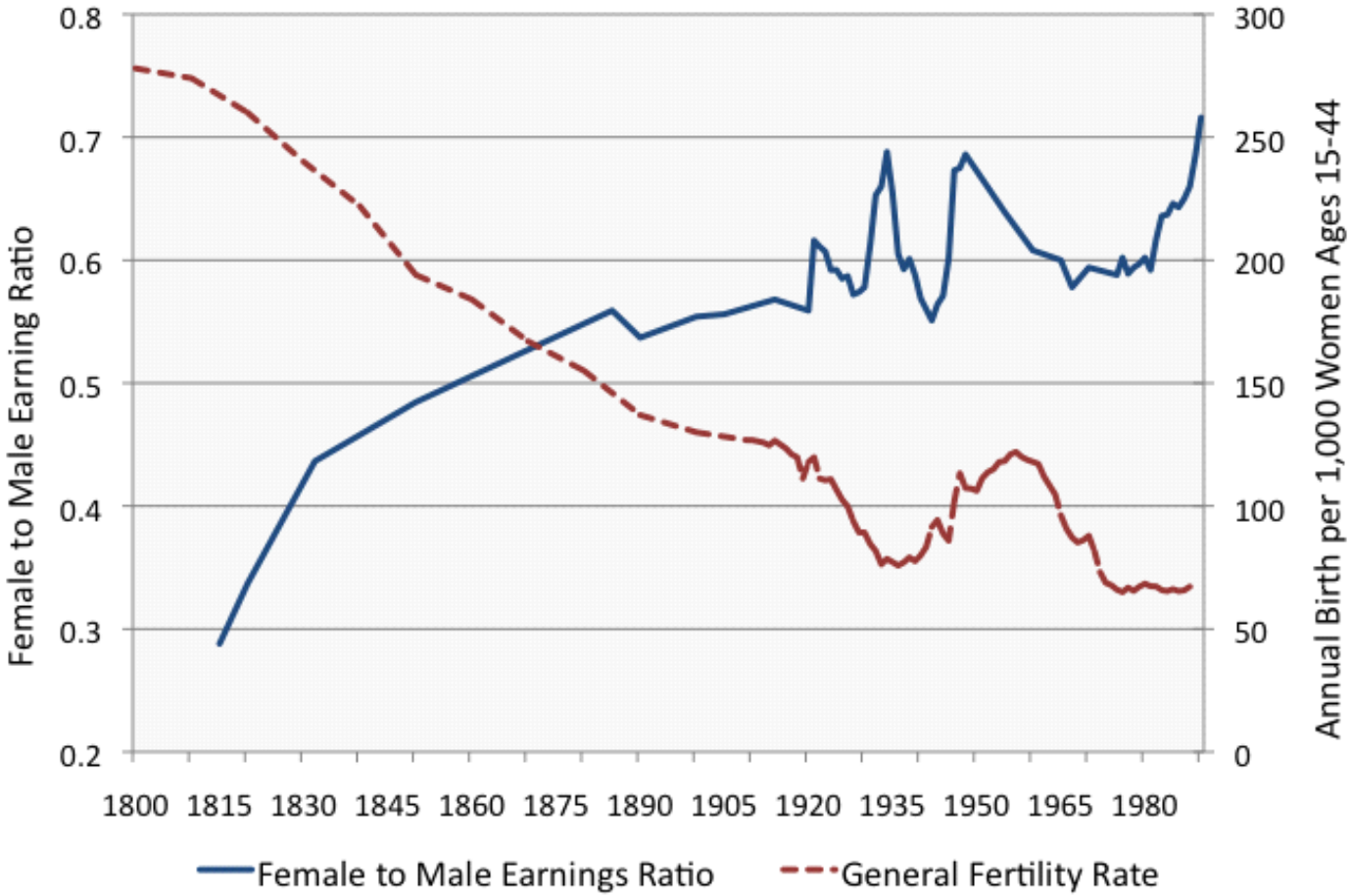
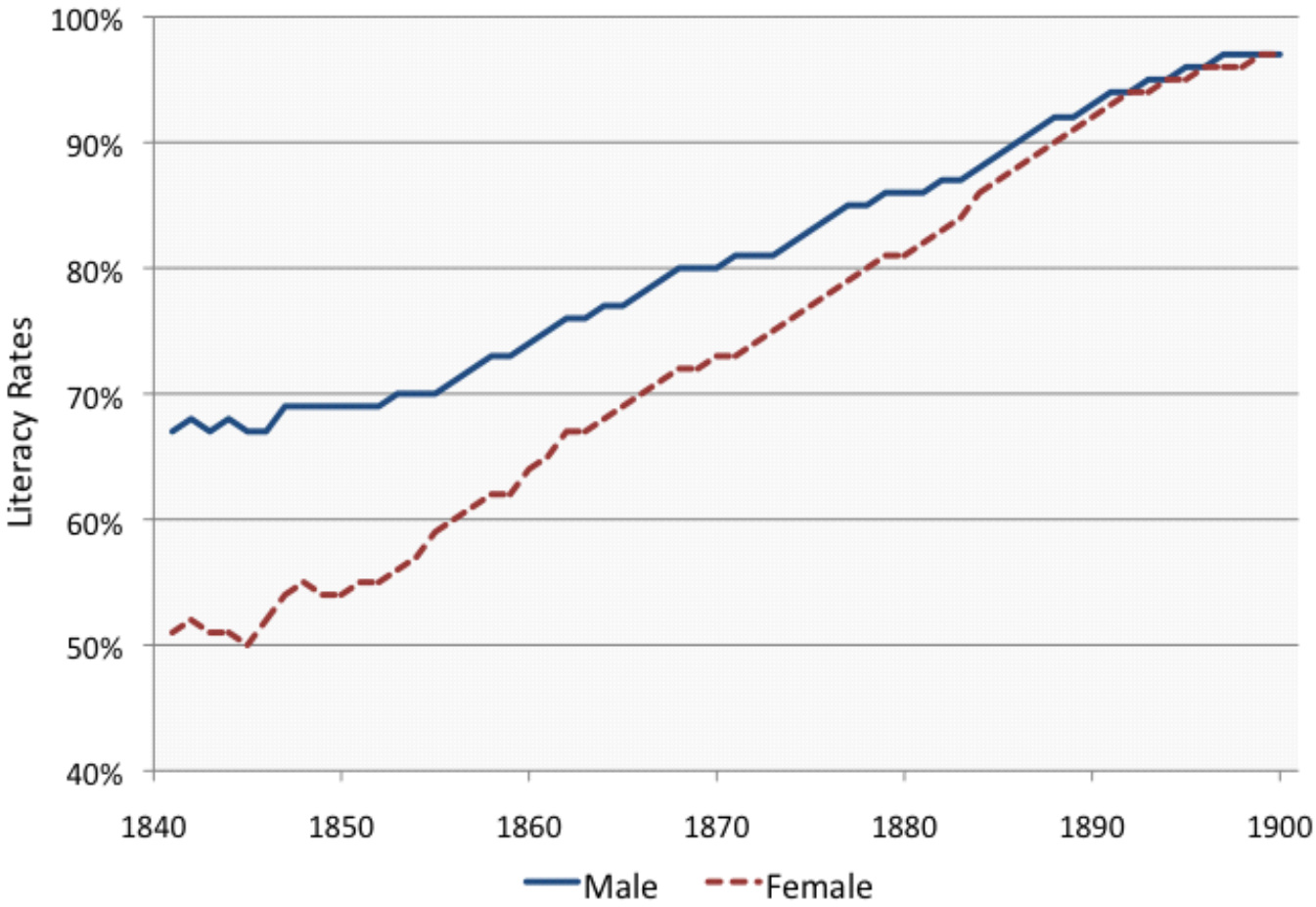


Evolution of the Gender Literacy Gap - England



Mechanism: II. Women's Relative Wages and Fertility

- Child rearing is time-intensive
- Women are the prime care-takers engaged in child rearing
- Budget constraint (if only women raise children)

$$w^F \tau n + c \leq w^M + w^F$$

  - $w^F + w^M \equiv$ household's income
  - $c \equiv$ household's consumption
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  - $\tau \equiv$ time cost per child
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Mechanism: II. Women's Relative Wages and Fertility

- The rise in women's wages, w^F, generates two conflicting effects:
  - An income effect:

$$w^F \tau n + c \leq w^M + [w^F] \Uparrow$$

    - More income for raising children $\Longrightarrow$ operates towards $n \Uparrow$
  - A substitution effect:

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The Decline in the Gender Wage Gap

- If women work and raise children, an increase in w^F increases the opportunity cost of raising children more than family income i.e.,

$$w^F \Uparrow \implies \left|\text{Income effect}\right| < \left|\text{Substitution effect}\right|$$

$$\implies n \Downarrow \text{ (even if preferences are homothetic)}$$

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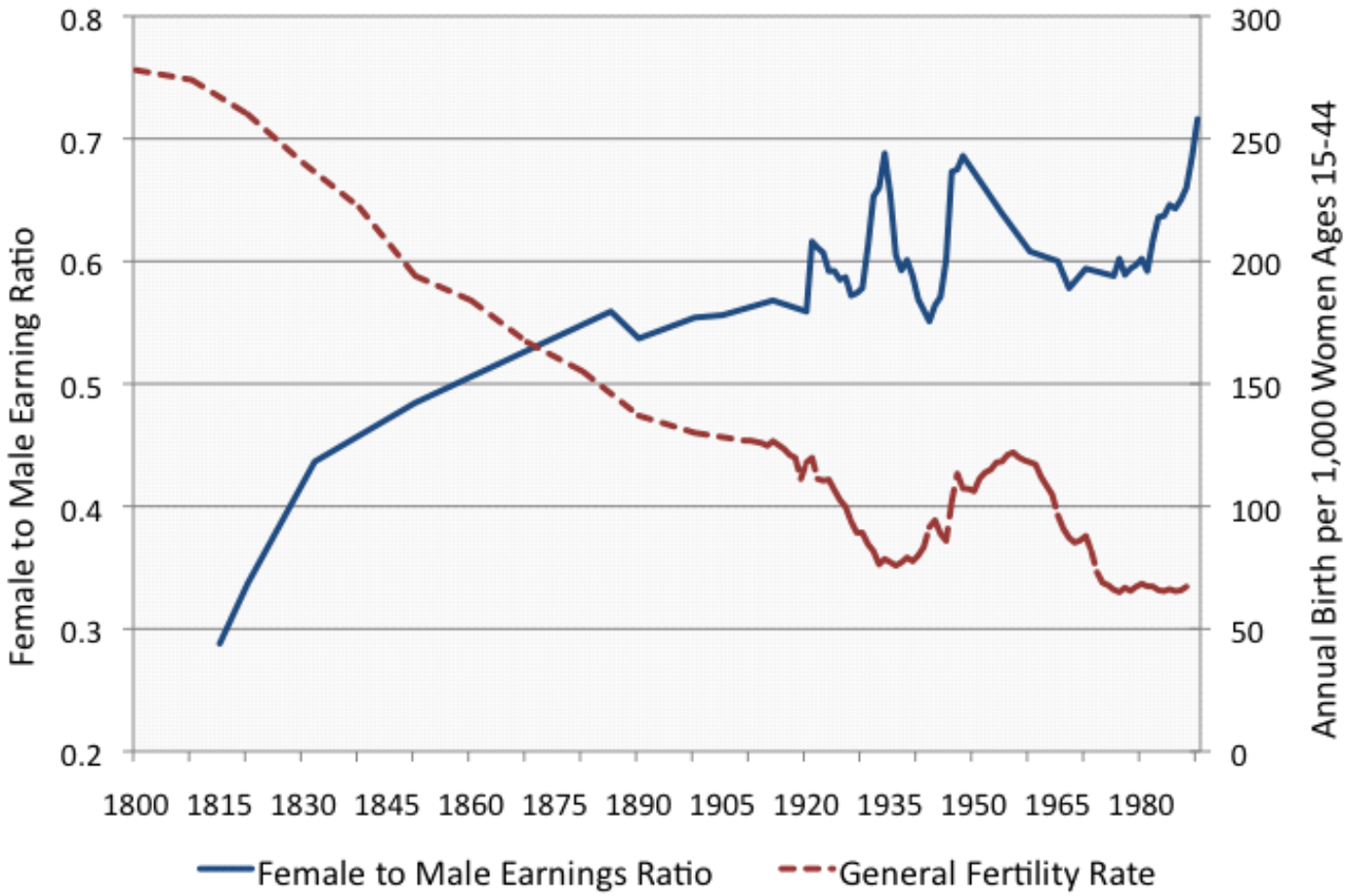

Women's Relative Wages and Fertility - Evidence

- US (1970s): $w^F \Uparrow \implies n \Downarrow$ & $w^M \Uparrow \implies n \Uparrow$ (Heckman and Walker ECT 79)
- Sweden's demographic transition: $(w^F/w^M) \Uparrow \implies n \Downarrow$ (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 2009)

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The Rise in the Demand for Human Capital - Main Thesis

- The acceleration in the rate of technological progress in the 2nd phase of industrialization increased the demand for human capital

  education enabled individuals to cope with a rapidly changing technological environment

- The rise in the demand for human capital induced a substitution of quality for quantity of children triggering a demographic transition

  $\Longrightarrow$ reduction in fertility

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The Model - Preferecnes

$$u = (1 - \gamma) \ln c + \gamma[\ln n + \beta \ln h]$$

- $c \equiv$ consumption
- $n \equiv$ (surviving) children
- $h \equiv$ quality (human capital) of each child
- $\beta \equiv$ degree of preference for child quality; $\beta < 1$

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$$yn(\tau^q + \tau^e e) + c \leq y$$

- $y \equiv$ household potential income
- $\tau^q \equiv$ fraction of the household's unit-time endowment required to raise a child, regardless of quality
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The Model - Human Capital Formation

$$h = h(e, g)$$

- $h_e(e, g) > 0$ & $h_{ee}(e, g) < 0$
  - HC is increasing (in decreasing rates) in the parental time investment in the education of the child
- $h_g(e, g) < 0$ & $h_{gg}(e, g) > 0$
  - HC is decreasing in the rate of technological progress (obsolescence of HC in a changing technological environment)
- $h_{eg}(e, g) > 0$
  - Education lessens the obsolescence of HC in a changing technological environment
- $h(0, g) > 0$ & $\lim_{e \to 0} h_e(e, g) = \infty$; $\lim_{e \to \infty} h_e(e, g) = 0$
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- $h(0, g) > 0$ & $\lim_{e \to 0} h_e(e, g) = \infty$; $\lim_{e \to \infty} h_e(e, g) = 0$
  - Basic level of human capital & interior solution

The Model - Human Capital Formation

$$h = h(e, g)$$

- $h_e(e, g) > 0$ & $h_{ee}(e, g) < 0$
  - HC is increasing (in decreasing rates) in the parental time investment in the education of the child
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The Model - Optimization

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

$$\text{since } c = y[1 - n(\tau^q + \tau^e e)] \iff$$

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Optimization

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

with respect to n:

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

$$\gamma[1 - n(\tau^q + \tau^e e)] = (1 - \gamma)(\tau^q + \tau^e e) n$$

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

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with respect to e :

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

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

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

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

Optimization

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

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

$\Longrightarrow$

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

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Testable Predictions - Investment in Quality

The optimal level of investment in child quality increases if:

- The technological environment changes more rapidly

$$\partial e(g, \beta, \tau^e, \tau^q)/\partial g > 0$$

- Preferences for child quality are higher

$$\partial e(g, \beta, \tau^e, \tau^q)/\partial \beta > 0$$

- The cost of raising a child (regardless of quality) increases

$$\partial e(g, \beta, \tau^e, \tau^q)/\partial \tau^q > 0$$

- The cost of educating a child decreases

$$\partial e(g, \beta, \tau^e, \tau^q)/\partial \tau^e < 0$$

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Testable Predictions - Investment in Quantity

The optimal number of children decreases if:

- The technological environment changes more rapidly

$$\partial n/\partial g < 0$$

- Preferences for child quality are higher

$$\partial n/\partial \beta < 0$$

- The cost of raising a child (regardless of quality) increases

$$\partial n/\partial \tau^q < 0$$

- 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

$$\partial n/\partial \tau^e < 0 \text{ if } [\partial e/\partial \tau^e][\tau^e/e] > -1$$

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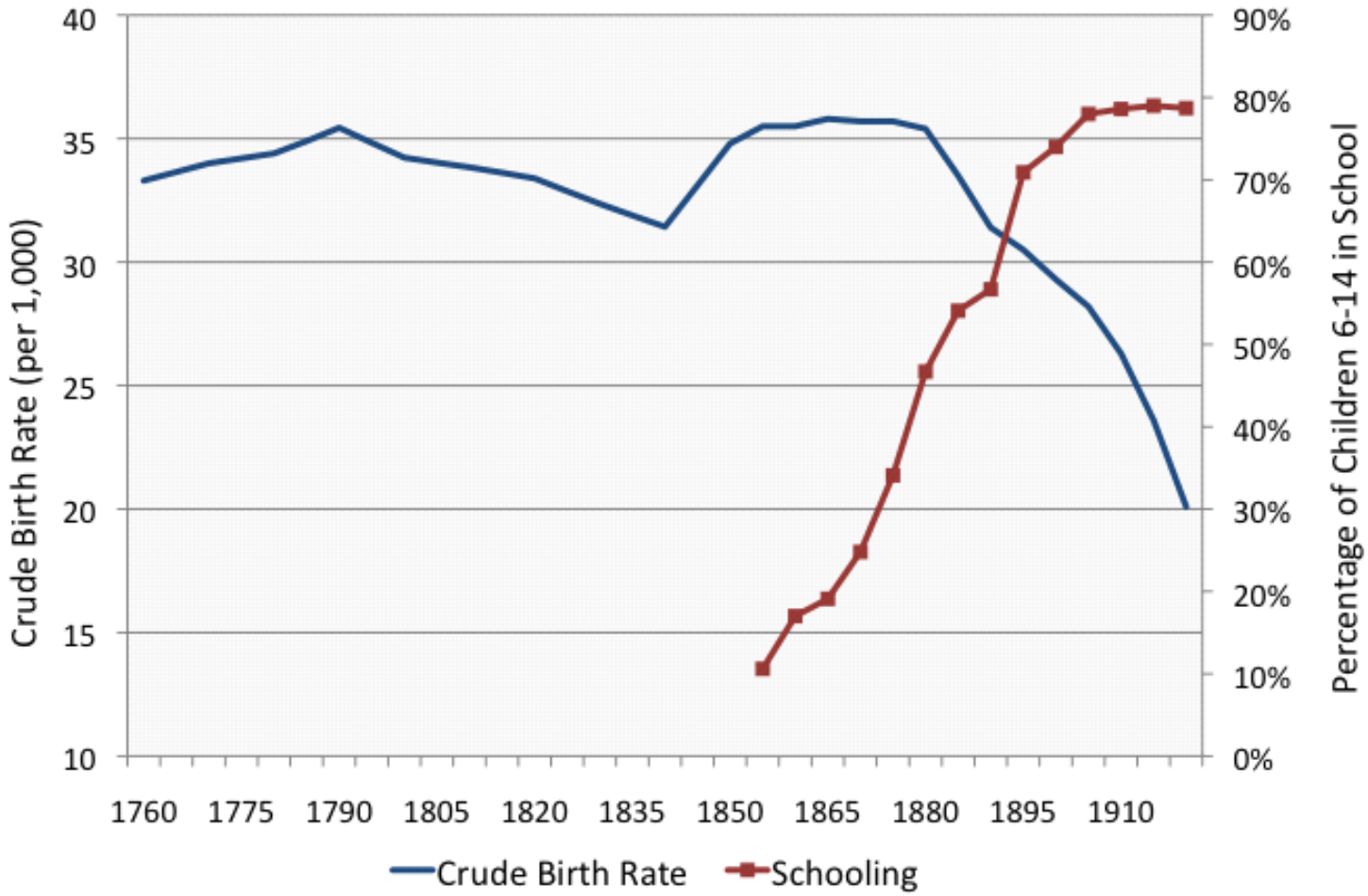
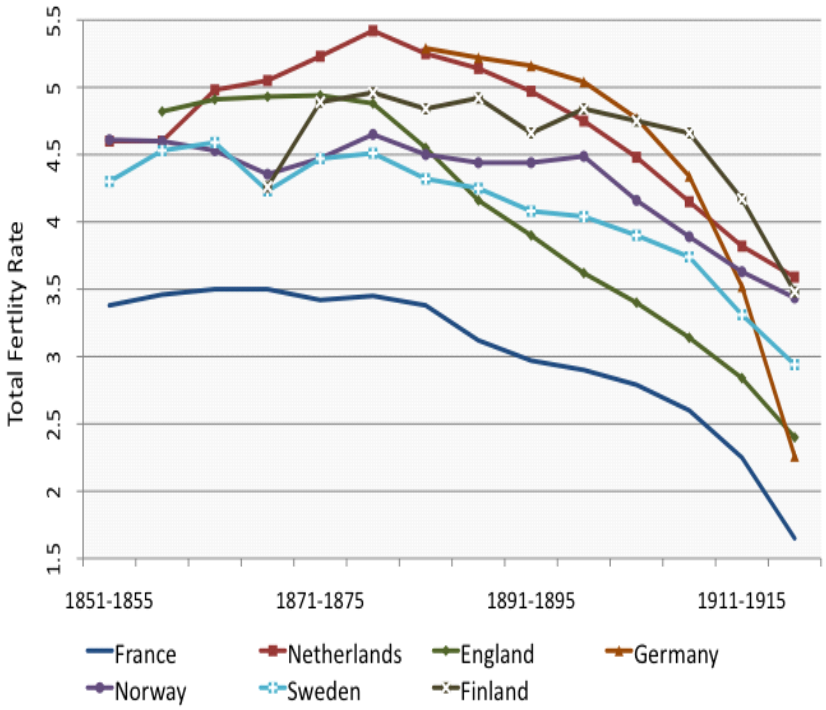
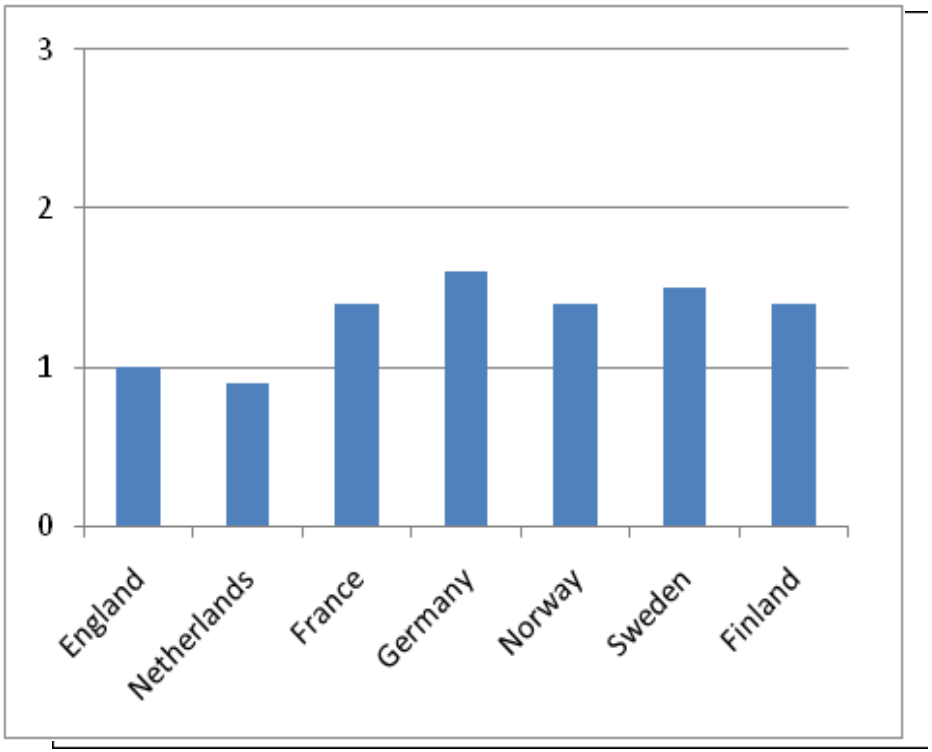
Human Capital Formation and the DT - England



Growth Rates 1870-1913 and DT





Supporting Evidence: Cross-Country

- Cross Section of Countries (1870-2000) - educational attainment has been negatively associated with fertility, accounting for income per worker and mortality rates (Murtin 2009).
- Cross Section of Countries (1960-1999): adverse effect on net fertility of an increase in productivity in advanced stages of development, when education demand dominates (Lehr 2009)

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- Prussia (19th century): the rise in human capital formation has had an adverse effect on fertility (IV: Land concentration & Distance from the birthplace of Protestantism - Wittenberg) (Becker-Cinnirella-Woessmann (2010)
- France (1876–96): the level of education attainment had an adverse effect on fertility rates during France's demographic transition, accounting for income per capita, the gender literacy gap, and mortality rates. (Murphy 2009)
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