

# The Demographic Transition

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Economic Growth and Comparative Development

## Phases of Development: Standard of Living

- The Malthusian Epoch
- The Post-Malthusian Regime
- The Modern Growth Regime

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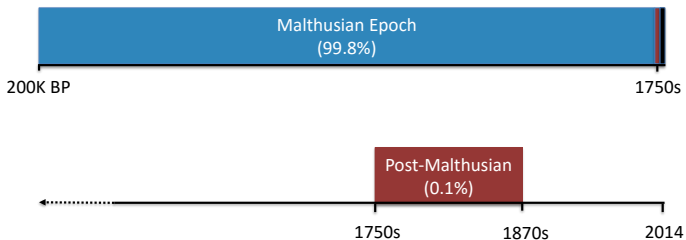
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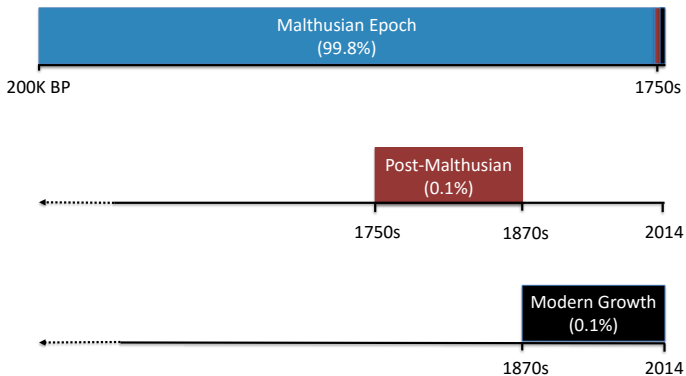
# Phases of Development: Timeline of the Most Developed Economies



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## The Demographic Transition

- The positive relationship between income and population is reversed
- Fertility, mortality and population growth decline very rapidly
- The impact of technological progress on output per capita are no longer counterbalanced by population growth
- Transition to Modern Growth



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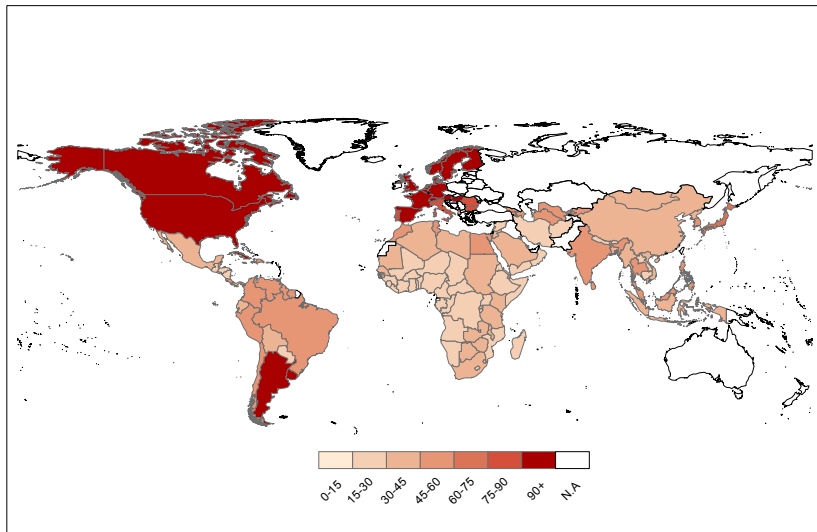
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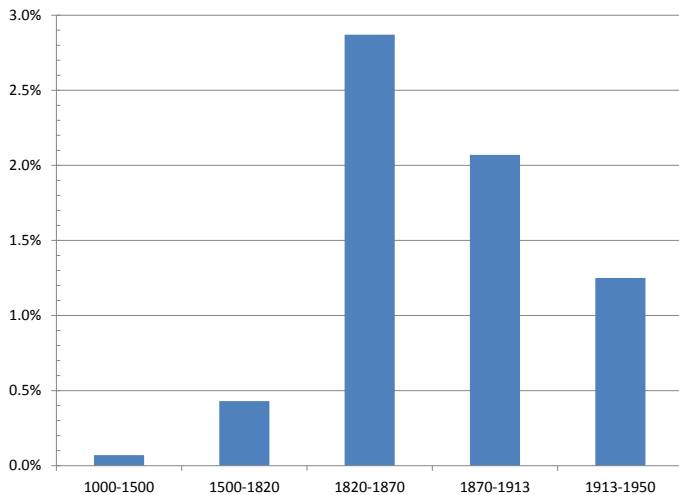
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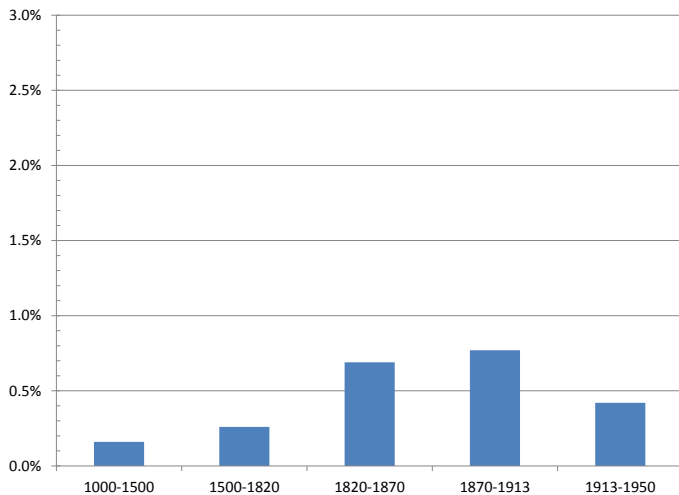
## Variation in years elapsed since the Onset of the Fertility Decline



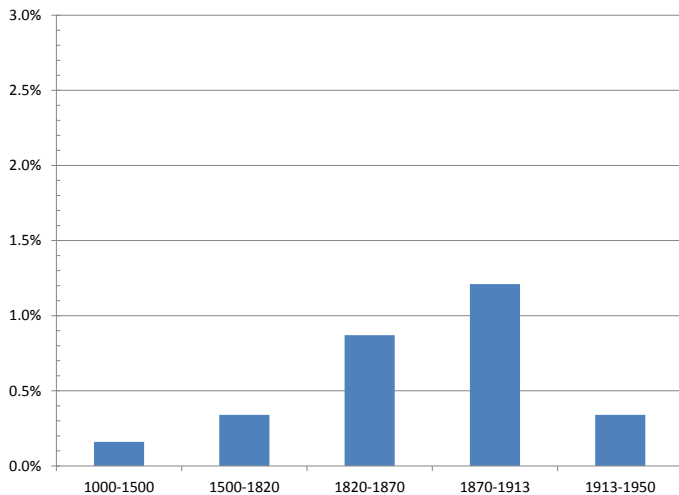
## Early Fertility Decline – Western Offshoots



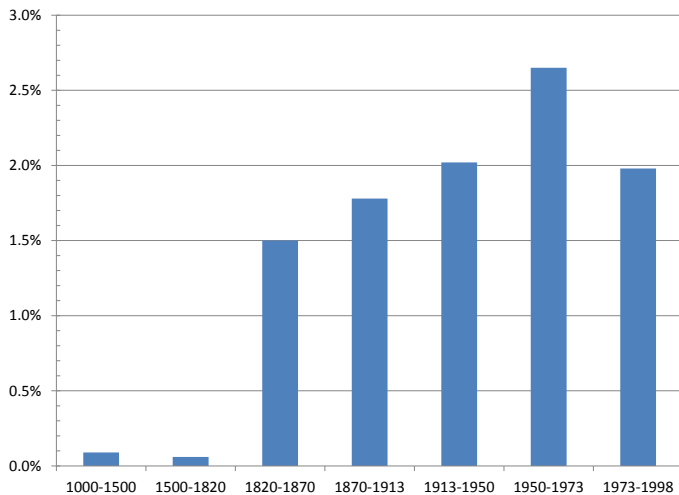
## Early Fertility Decline – Western Europe



## Early Fertility Decline – Eastern Europe

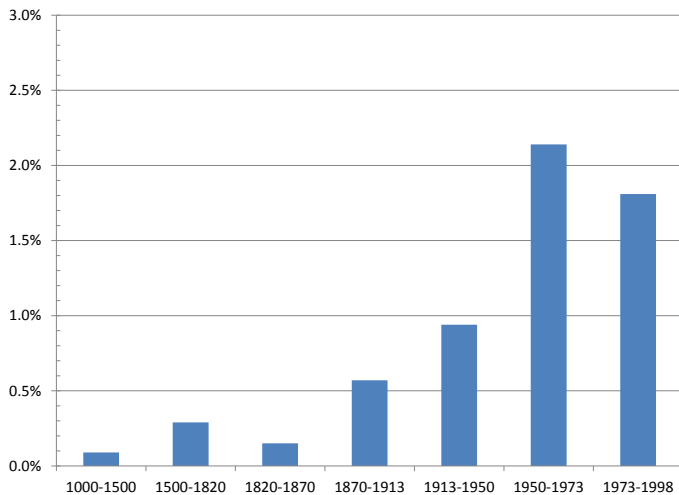


## Late Fertility Decline – Latin America

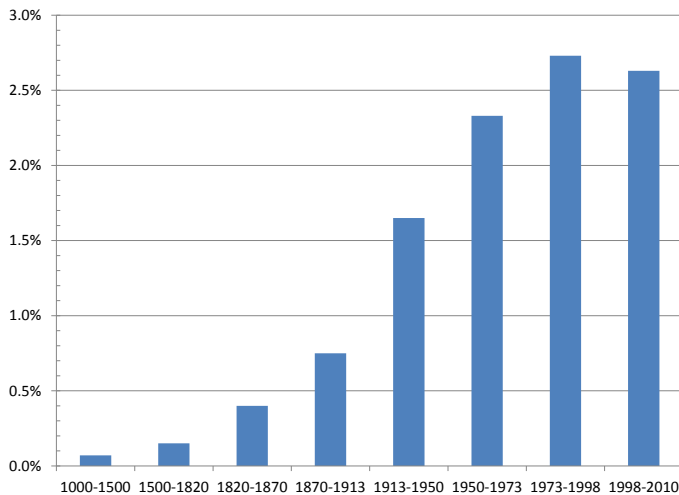




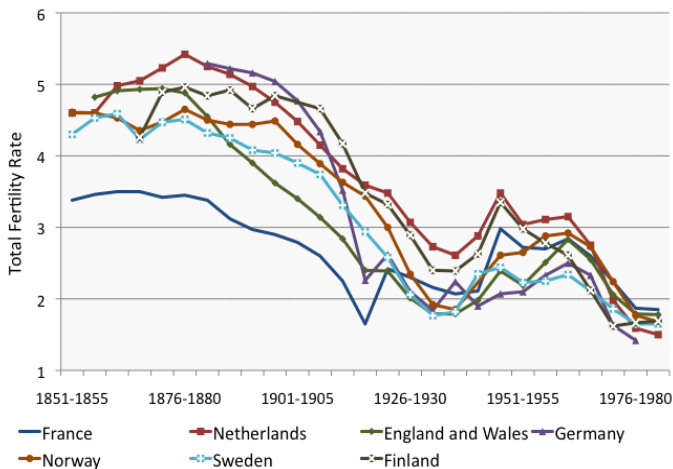
## Late Fertility Decline – Asia



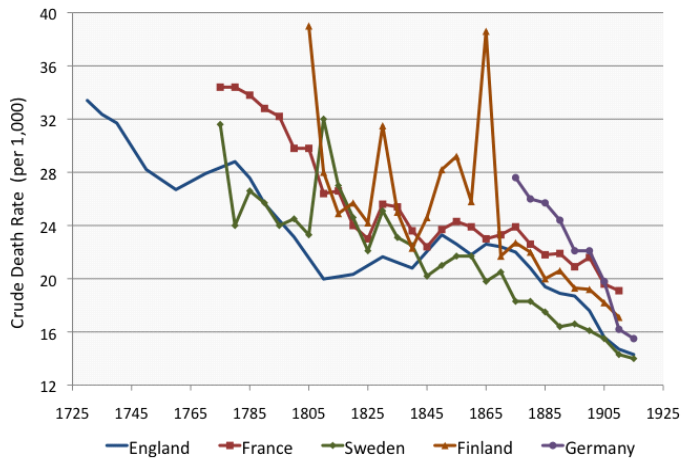
## Late Fertility Decline – Africa



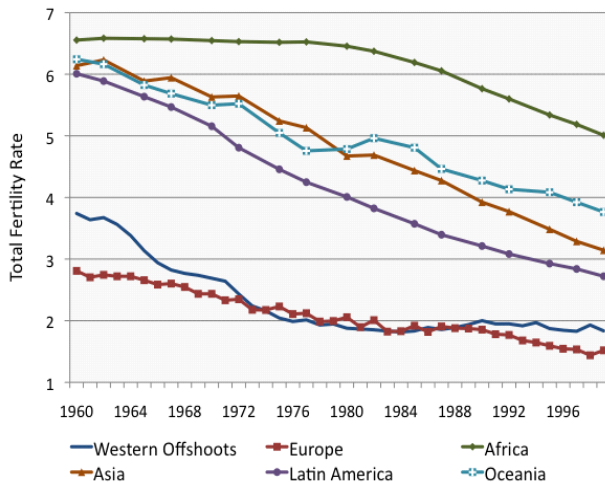
# The Demographic Transition in Western Europe: Total Fertility Rates



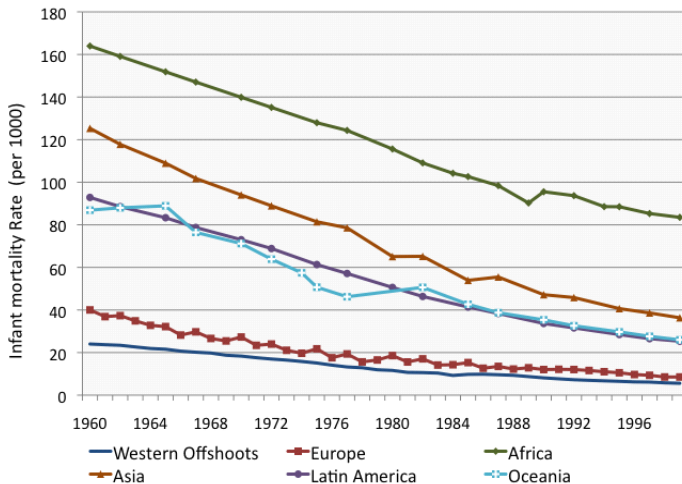
## Mortality Decline Western Europe: 1730-1920



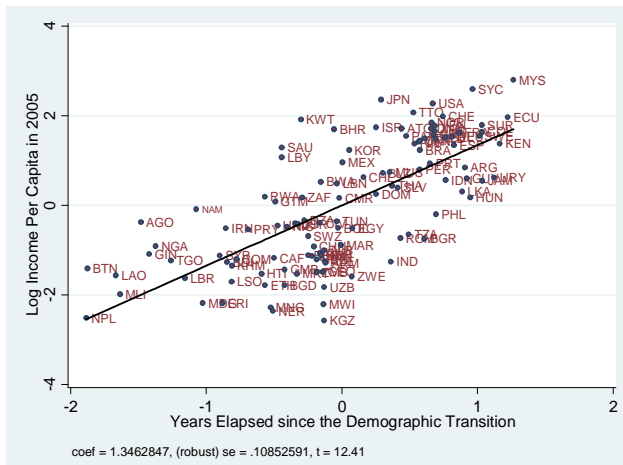
# The Evolution of Total Fertility Rate across Regions, 1960-1999



## Decline in infant mortality rates across regions, 1960-1999



## Timing of the Demographic Transition and Current Income per Capita



Conditional on absolute latitude.

# Theories of the Demographic Transition

- The Rise in Income (Becker, 1960)
  - The cost of raising children is primarily parental time
    - The rise in income increased the opportunity cost of raising children  $\Rightarrow$  reduction in fertility (Becker, 1960)
  - The income elasticity of child quality is larger than that of quantity
    - The rise in income  $\Rightarrow$  substitution of child quality for quantity  $\Rightarrow$  reduction in fertility (Becker and Lewis, JPE 1973)
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- The Old-Age Security Hypothesis (Caldwell, 1976)
  - Children is a form of investment good (in the absence of access to financial markets)
    - Development of financial markets reduced the demand for children as an investment good
      - ⇒ reduction in fertility
- The Decline in the Gender Wage Gap (Galor-Weil, AER 1996))
  - The process of development decreased the gender wage gap
    - The rise in the relative wages of women increased the opportunity cost of raising children more than family income ⇒ reduction in fertility

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## The Rise in Income: Mechanism

- Child rearing is time-intensive
- Household's Budget constraint

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

- $y \equiv$  household's income
- $c \equiv$  household's consumption
- $n \equiv$  household's children
- $\tau \equiv$  time cost per child
- $y\tau \equiv$  opportunity cost of raising a child

- Equivalently

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

- $1 \equiv$  household's time endowment
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- 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:

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

- The opportunity cost of raising children increases
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## The Rise in Income: Mechanism

- The rise in income generates two conflicting effects:

- An income effect:

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

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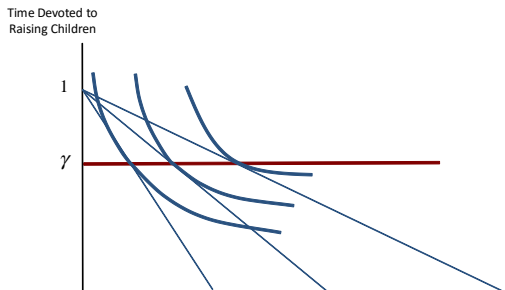
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## The Rise in Income: Testable predictions

- Across countries that are similar in sociocultural characteristics (and thus in noneconomic factors that may affect fertility decisions), the timing of the fertility decline is inversely related to the level of income per capita.
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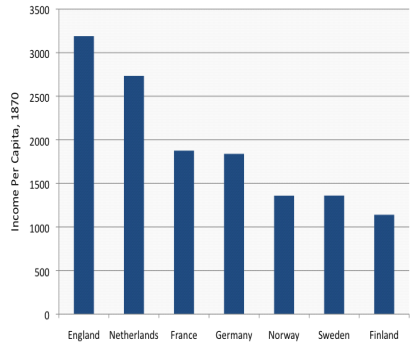
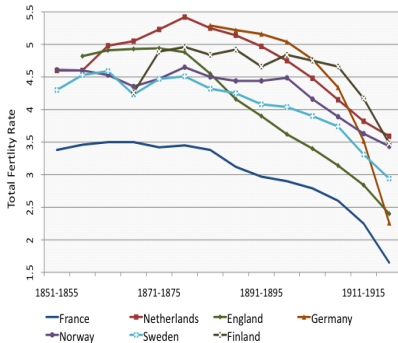
## The Rise in Income: Refuting Cross Country Evidence

- Cross Section of Countries (1870-2000) - Income per worker was positively associated with fertility rates, accounting for mortality rates and education (Murtin 2009).
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# Simultaneous DT across European Countries that Differ in Income per Capita



## The Rise in Income: Refuting Evidence from Individual Countries

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## The Decline in Child Mortality - Main Hypothesis

- Parents generate utility from the number of surviving children
- A decline in child mortality permits parents to reach a given level of surviving children with lower fertility
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## The Decline in Mortality – Mechanism

- Preferences:

$$u = n^{\gamma} c^{(1-\gamma)} \quad 0 < \gamma < 1$$

- $c \equiv$  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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- Worldwide: NRR and TFR plummet jointly during the demographic transition. But the theory does not predict a decline in NRR
- NRR does not decline unless:
  - There exists a precautionary demand for children
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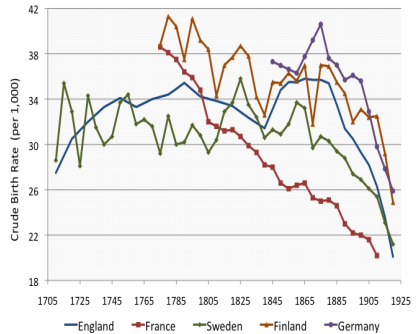
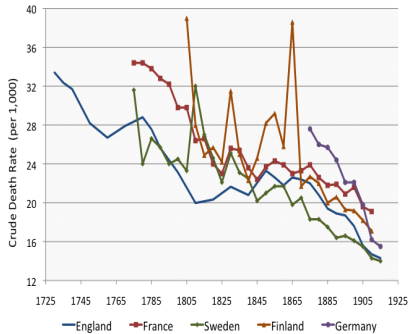
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# The Decline in Mortality and Fertility - Evidence



## The Decline in Child Mortality – Challenges to the Theory

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- England: The decline in mortality started in England in the 1730s (140 years before the fertility decline) and was accompanied by a steady increase in fertility rates until 1800



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## The Old-Age Security Hypothesis - Challenges to the Theory

- 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
  - England (16th century) Parents did not rely on support from children in their old age (Pelling and Smith-1994)
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## Mechanism: I. Development and Women's Wages

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  - Mechanization and advanced technologies have complemented mental tasks more than physical tasks
  - Women have physiological comparative advantage in mental (rather than physical) tasks
- $\implies$  The process of development has (inevitably) increased the productivity of women relative to men:

$$\text{Economic Development} \implies (w^F/w^M) \uparrow\uparrow$$

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$$\text{Economic Development} \implies (w^F / w^M) \uparrow\uparrow$$

- $w^F \equiv$  women's wages
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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
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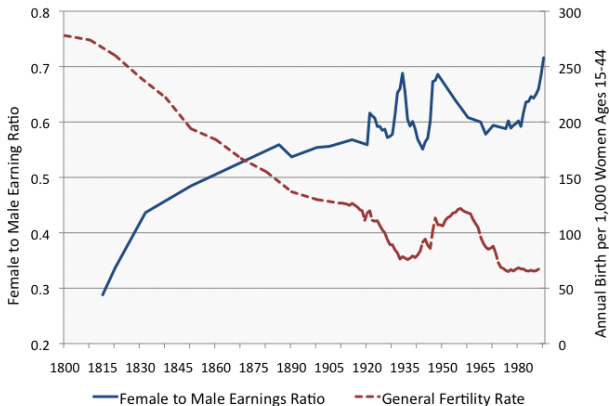
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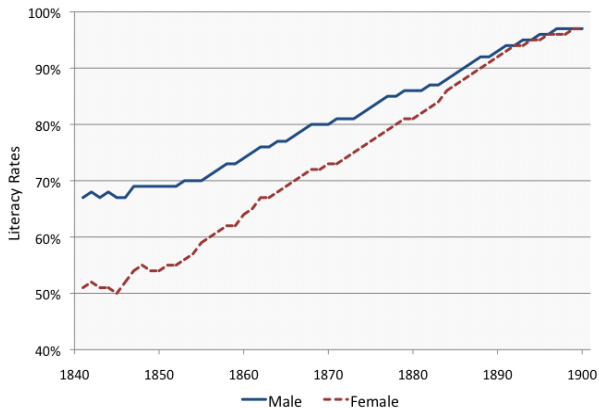
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## Evolution of the Gender Earning Ratio - US



## 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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## 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  $\Rightarrow$  operates towards  $n \uparrow$

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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.,

$$w^F \uparrow \implies |\text{Income effect}| < |\text{Substitution effect}|$$

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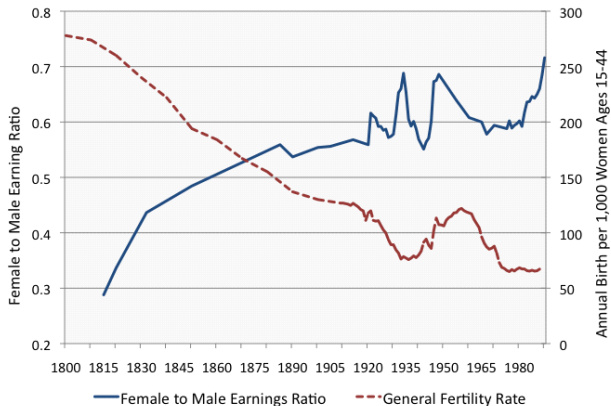
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## Women's Relative Wages and Fertility - US



## 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 2015)

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

- $c \equiv$  consumption
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- $h \equiv$  quality (human capital) of each child
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$$yn(\tau^q + \tau^e e) + c \leq y$$

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

- $h_e(e, g) > 0$  &  $h_{ee}(e, g) < 0$ 
  - HC is increasing (at 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)
- $h_{eg}(e, g) > 0$ 
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- $h(0, g) > 0$  &  $\lim_{e \rightarrow 0} h_e(e, g) = \infty$ ;  $\lim_{e \rightarrow \infty} h_e(e, g) = 0$ 
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$$h = h(e, g)$$

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## The Model - Optimization

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

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

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with respect to  $n$ :

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

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

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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

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- 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:

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- 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

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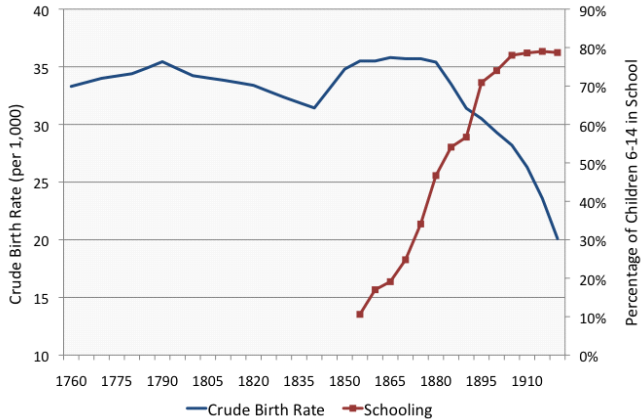
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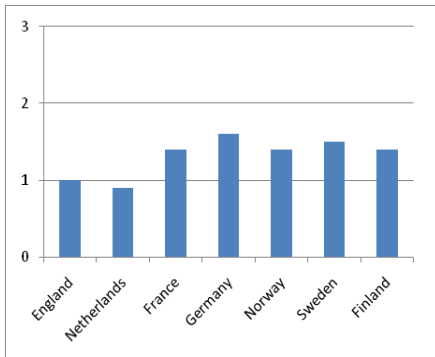
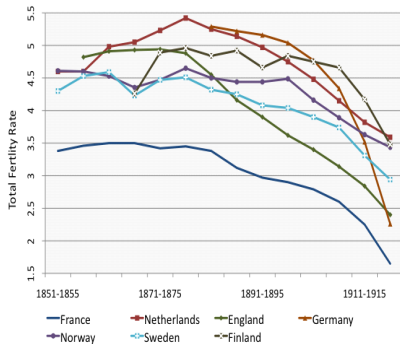
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## Human Capital Formation and the DT - England



## 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 2015).
- 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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- US (1910s): Eradication of hookworm – a positive shock to the return to child quality - had an adverse effect on fertility (Bleakley-Lange-2009)
- 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 2015)
- England (1580-1871) Adverse effect of family size on children's literacy. (Klemp-Weisdorf 2016)



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