Economic Growth over the Very Long Run

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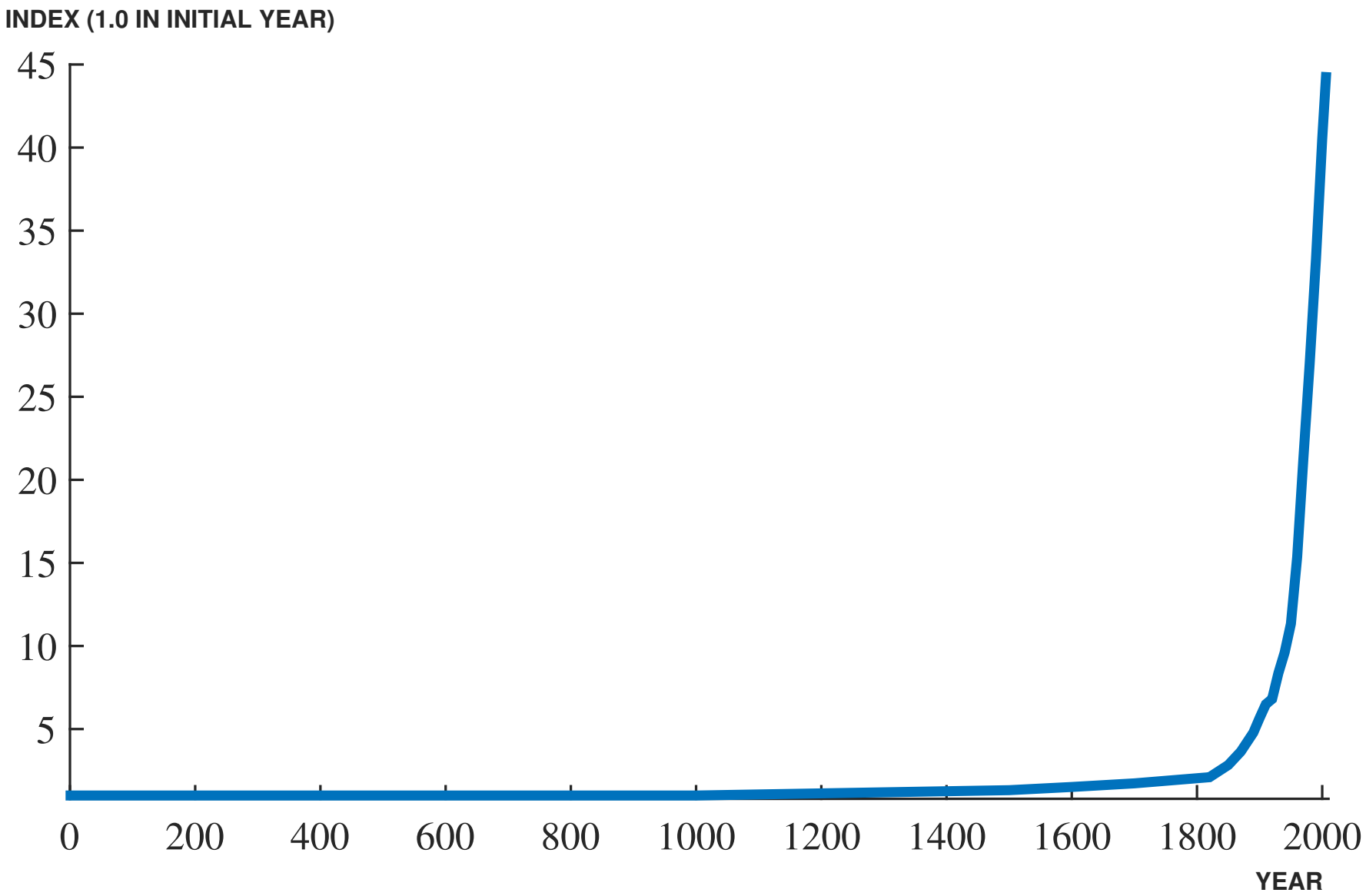
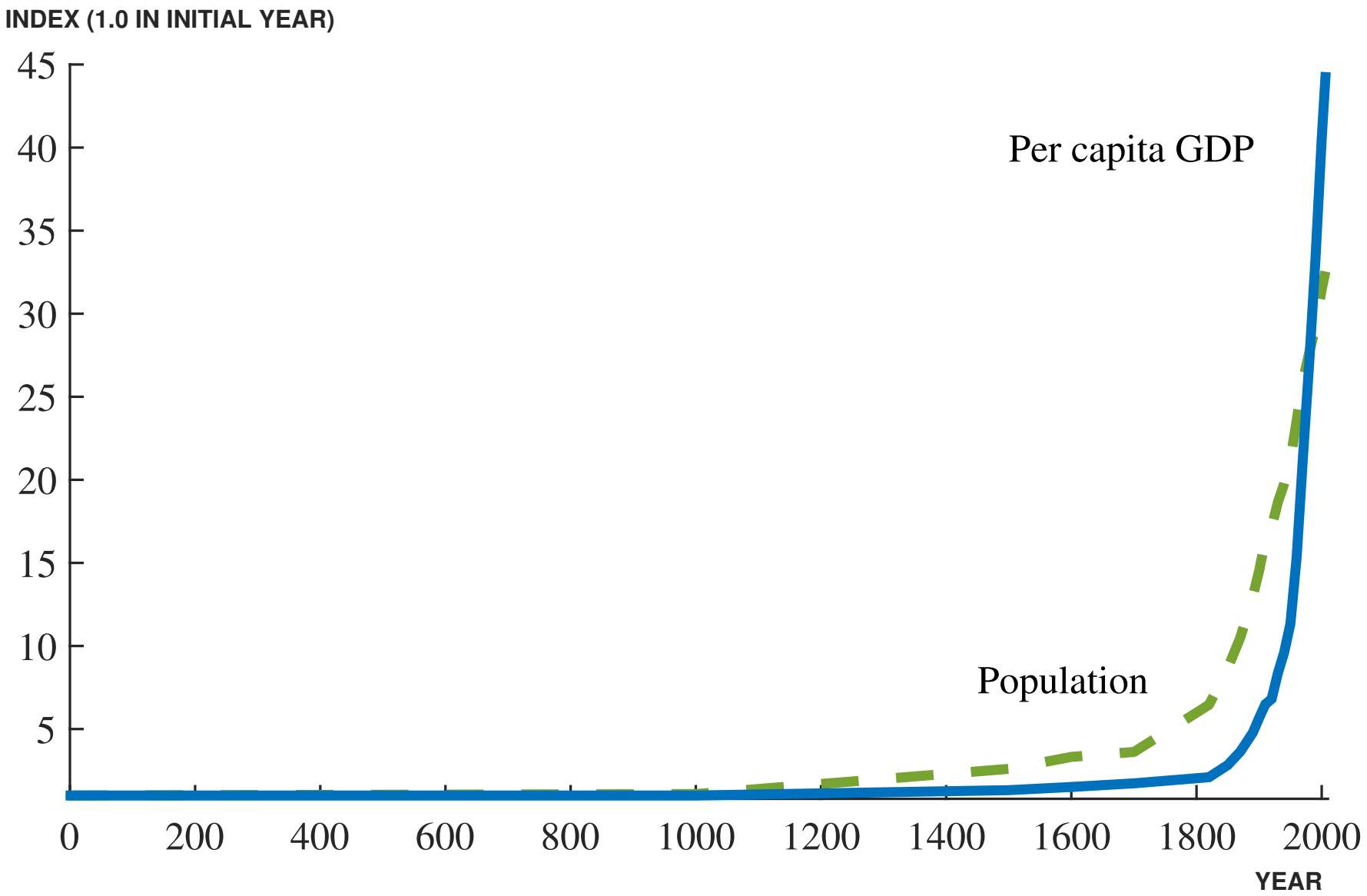
Stanford GSB

What is graphed here?



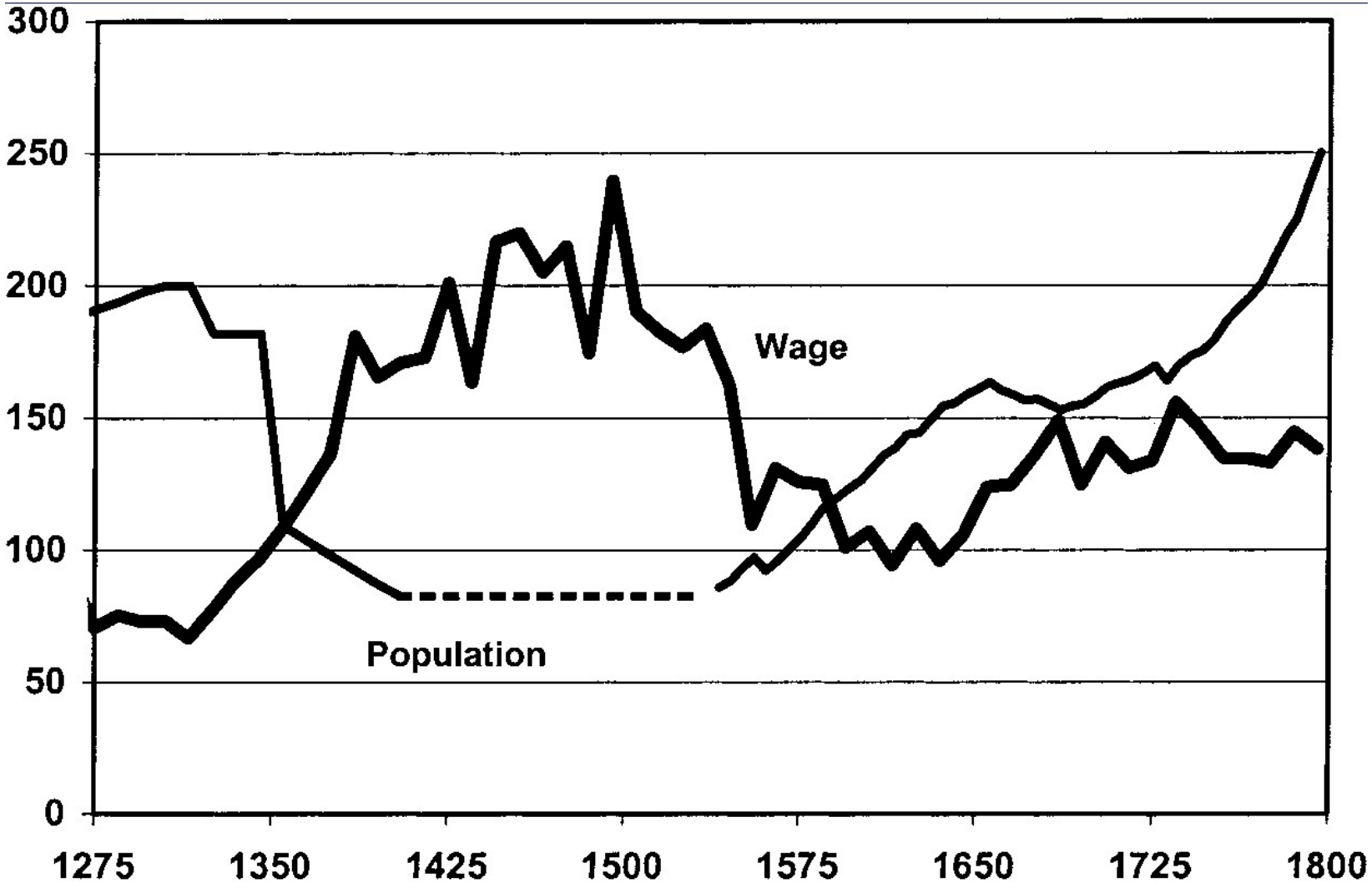
Population and Per Capita GDP: the Very Long Run



Key Ingredients of Main Models

- Malthusian Land: $Y = F(A, K, L, T)$
  - Fixed supply of land
  - Decreasing returns to scale holding technology fixed.
- Demographic transition
  - Fertility at first rises with income
  - But eventually declines
- Some kind of growth process
  - Lee / Kremer / Jones: Ideas
  - Lucas / Galor: Human capital
  - Hansen-Prescott: Solow exogenous tech change

Evidence for Malthusian Channel? The Black Plague



Ron Lee (1988) Model

- Basic Setup:

$$Y_t = A_t L_t^{1-\beta} T_t^{\beta}, \quad T_t = 1,$$

$$\frac{\dot{A}_t}{A_t} = \gamma \log L_t, \quad A_0 \text{ given},$$

$$\frac{\dot{L}_t}{L_t} = \alpha \left(\log \frac{Y_t}{L_t} - \log \bar{y} \right), \quad L_0 \text{ given}.$$

- Let $a \equiv \log A$ and $\ell \equiv \log L$

$$\dot{a}_t = \gamma \ell_t,$$
$$\dot{\ell}_t = \alpha a_t - \alpha\beta \ell_t.$$

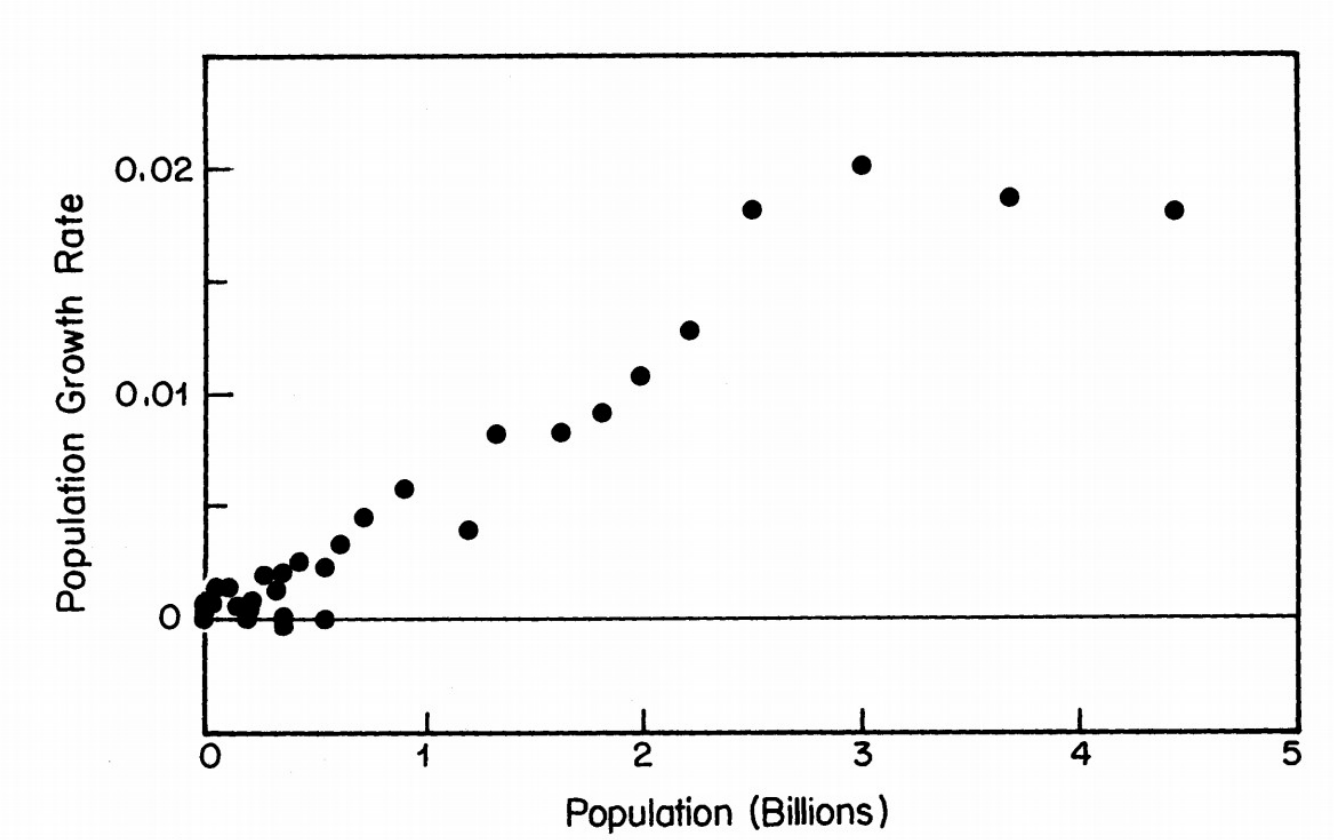
It is straightforward to solve this system to find

$$\log \frac{Y_t}{L_t} = \omega_1 e^{\theta_1 t} + \omega_2 e^{\theta_2 t},$$

- Double exponential growth — growth rates grow exponentially!
- People produce ideas and ideas produce people, with IRS

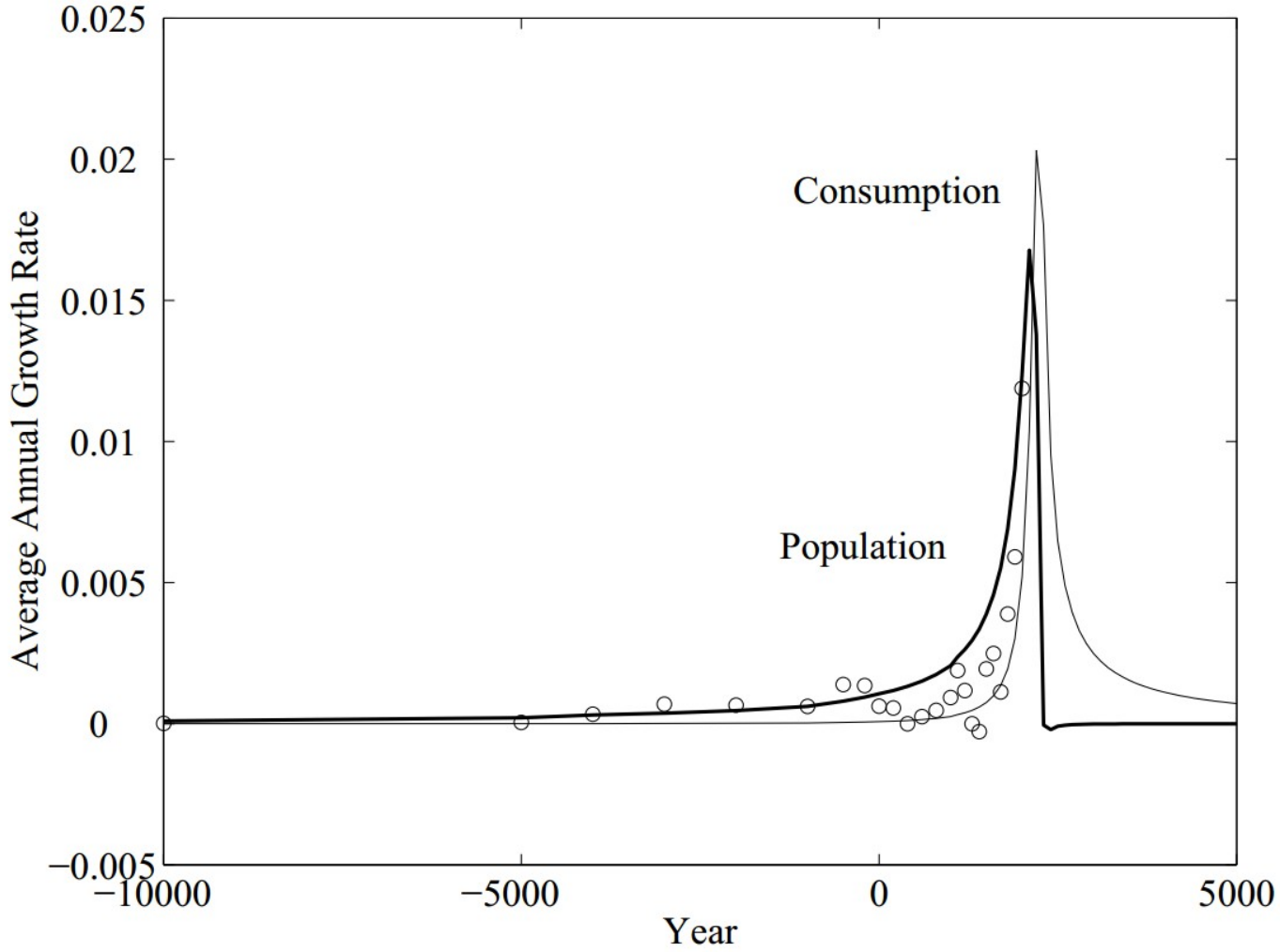
Kremer (1993): Million B.C. to Present

- Builds on Lee (1988) and provides empirical support



Jones (2001): Inevitable Industrial Revolution?

- Builds on Kremer (1993) with $\phi < 1$.



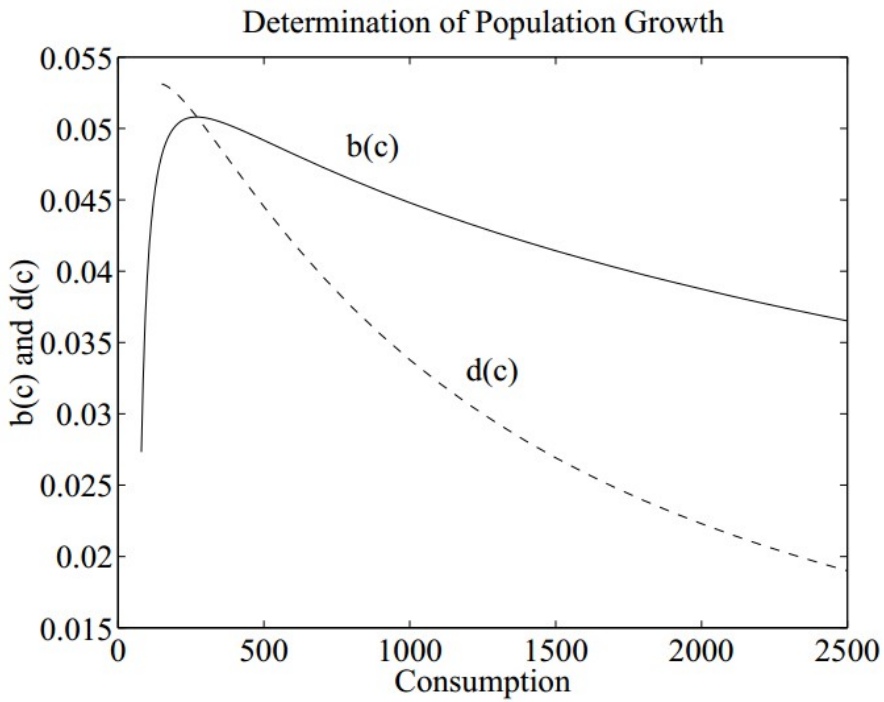
Key Condition

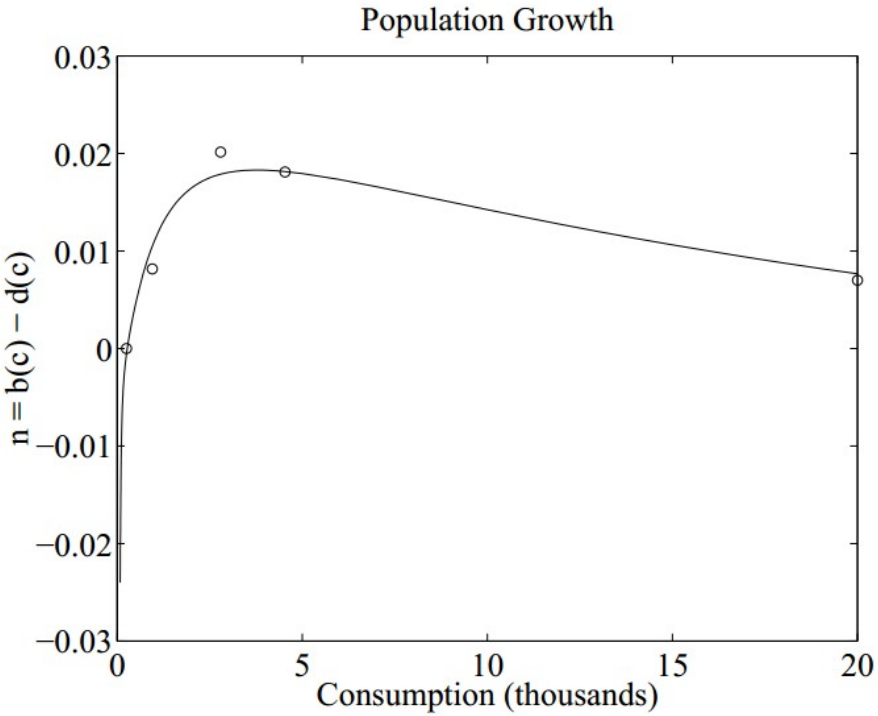
- Suppose $Y = A^{\sigma} K^{\alpha} T^{\beta} L^{1-\alpha-\beta}$ and $\dot{A} = L^{\lambda} A^{\phi}$
- A crucial condition for getting the "hockey stick" is

$$\frac{\sigma}{1-\alpha} \cdot \frac{\lambda}{1-\phi} > \beta$$

- Why?

Key Ingredient: The Demographic Transition





Why does fertility rise then fall with consumption?

- Income effect and Subsistence effect
  - IE: Richer $\Rightarrow$ more of all goods, including kids
  - Subsistence: Must consume at least $\bar{c}$ to live
- Substitution effect
  - As wage rate rises, kids are more expensive
- Need the substitution effect to eventually dominate if you want fertility to fall.
  - Becker / Lucas / Galor alternative: quality vs quantity
  - Eventually value quality (purchased with goods) over quantity (time)

Oded Galor's Unified Growth Theory

- Starting with Galor and Weil (2000). See also Lucas (1998).
- Nutshell version:
  - Lee-Kremer like mechanism initially lifts incomes
  - Induces human capital accumulation, driving growth
  - Demographic transition via quality-quantity tradeoff
- Extensive follow up research
  - Natural selection
  - Role of geography and timing of the neolithic revolution
    Guns, Germs, and Steel
  - Biocultural origins of human capital formation

Hansen and Prescott (2002): Malthus to Solow

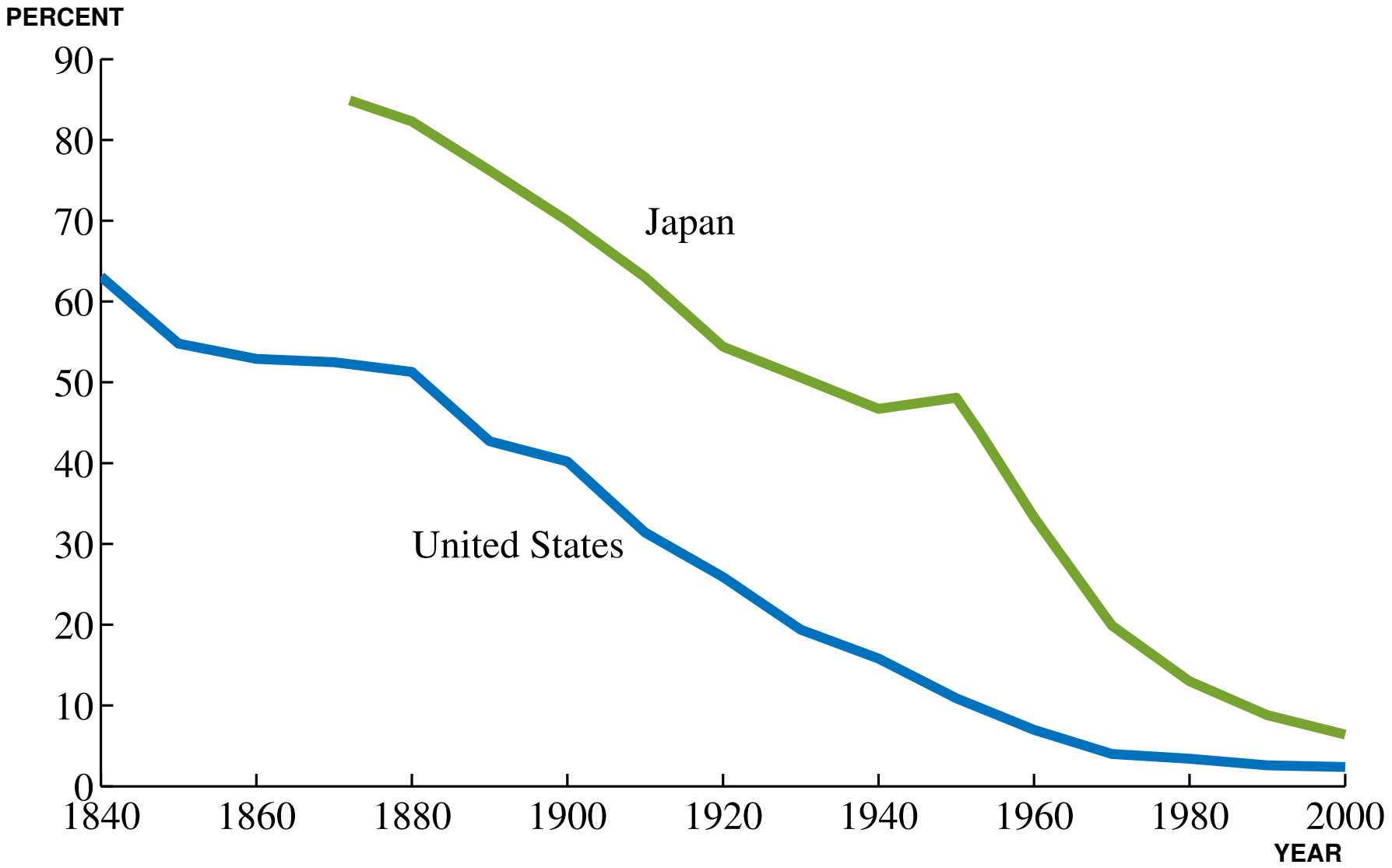
- Two production technologies available at all times
  - Malthus: $Y_m = A_m K_m^{\phi} N_m^{\mu} L^{1-\phi-\mu}$
  - Solow: $Y_s = A_s K_s^{\theta} N_s^{1-\theta}$
  - Exogenous growth in both A_m and A_s
  - Mechanical demographic transition
- Can use either technology to make homogenenous output:

$$F(K, N, L)$$

$$\equiv \max_{\substack{0 \le K_S \le K \\ 0 \le N_S \le N}} \{A_M (K - K_S)\phi (N - N_S)^{\mu} L^{1-\phi-\mu} + A_S K_S^{\theta} N_S^{1-\theta}\}.$$

- Key assumption: A_s initially low, but grows faster than A_m

Employment in Agriculture



Main Results of Hansen and Prescott

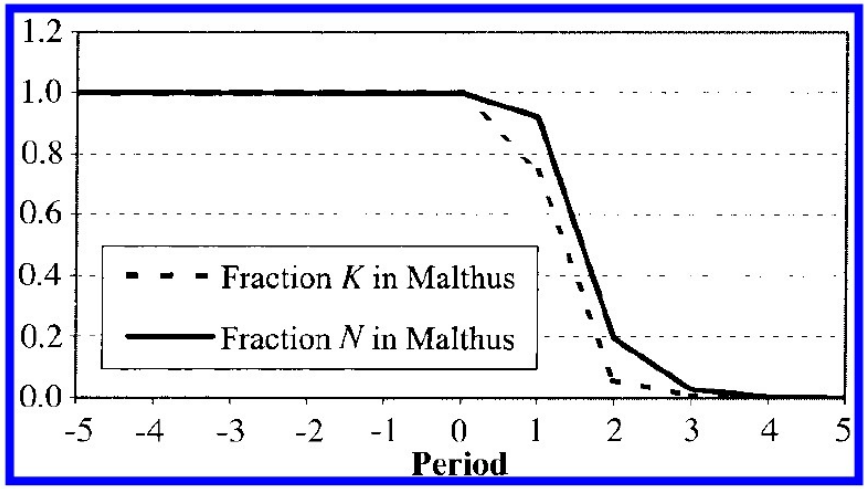


FIGURE 4. FRACTION OF INPUTS EMPLOYED IN MALTHUS SECTOR (K = CAPITAL; N = LABOR)

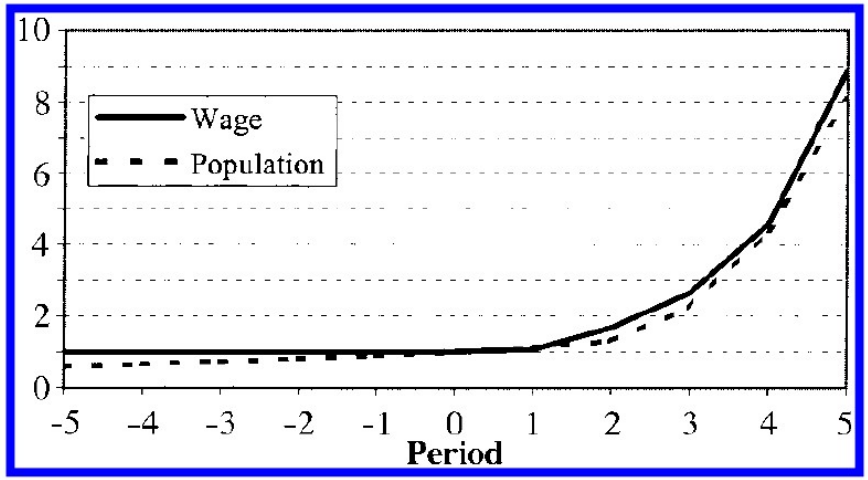


FIGURE 5. WAGE AND POPULATION

fraction of productive inputs (capital and labor) employed in the Malthus sector each period. The transition takes three generations (105 years) from the point at which the Solow technology is first used until over 99 percent of the resources are allocated to the Solow sector. As in the English industrial revolution, the transition to a modern industrial economy is not instantaneous, but takes generations to achieve.[22]

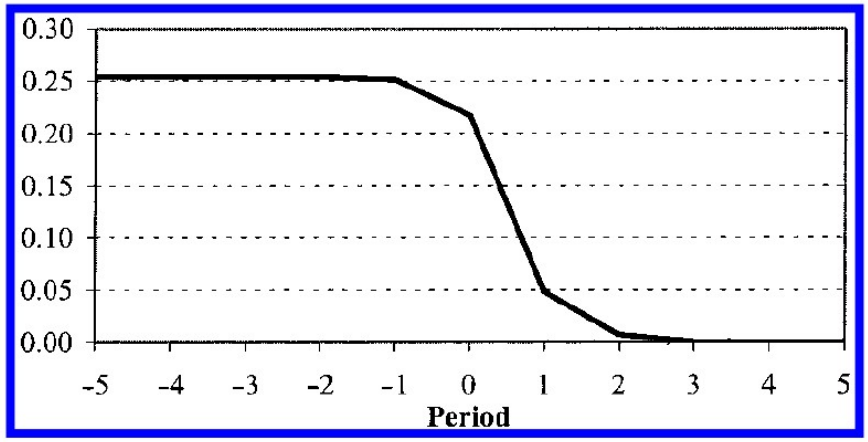


FIGURE 6. VALUE OF LAND RELATIVE TO OUTPUT

Directions for further research?

- How to endogenize fertility?
  - Cordoba and Ripoll, “The Elasticity of Intergenerational Substitution, Parental Altruism, and Fertility Choice” 2014 working paper.
  - Quality-quantity tradeoff surely important here.
- Why U.K. instead of China?
- Role of institutions

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