Economic Growth over the Very Long Run

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What is graphed here?
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


- 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 homogeneous output:
  
  \[
  F(K, N, L) \equiv \max_{0\leq K_S \leq K, 0\leq N_S \leq N} \{ A_M(K - K_S)\phi(N - N_S)^\mu L^{1-\phi-\mu} + A_S K_S^\theta N_S^{1-\theta} \}.
  \]

- Key assumption: \( A_s \) initially low, but grows faster than \( A_m \)
Employment in Agriculture

YEAR
1840 1860 1880 1900 1920 1940 1960 1980 2000
PERCENT
0 10 20 30 40 50 60 70 80 90

United States

Japan

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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
Directions for further research?

• How to endogenize fertility?
  ◦ Quality-quantity tradeoff surely important here.

• Why U.K. instead of China?

• Role of institutions
References


