Human Evolution and Economic Development

Oded Galor

October 8, 2019

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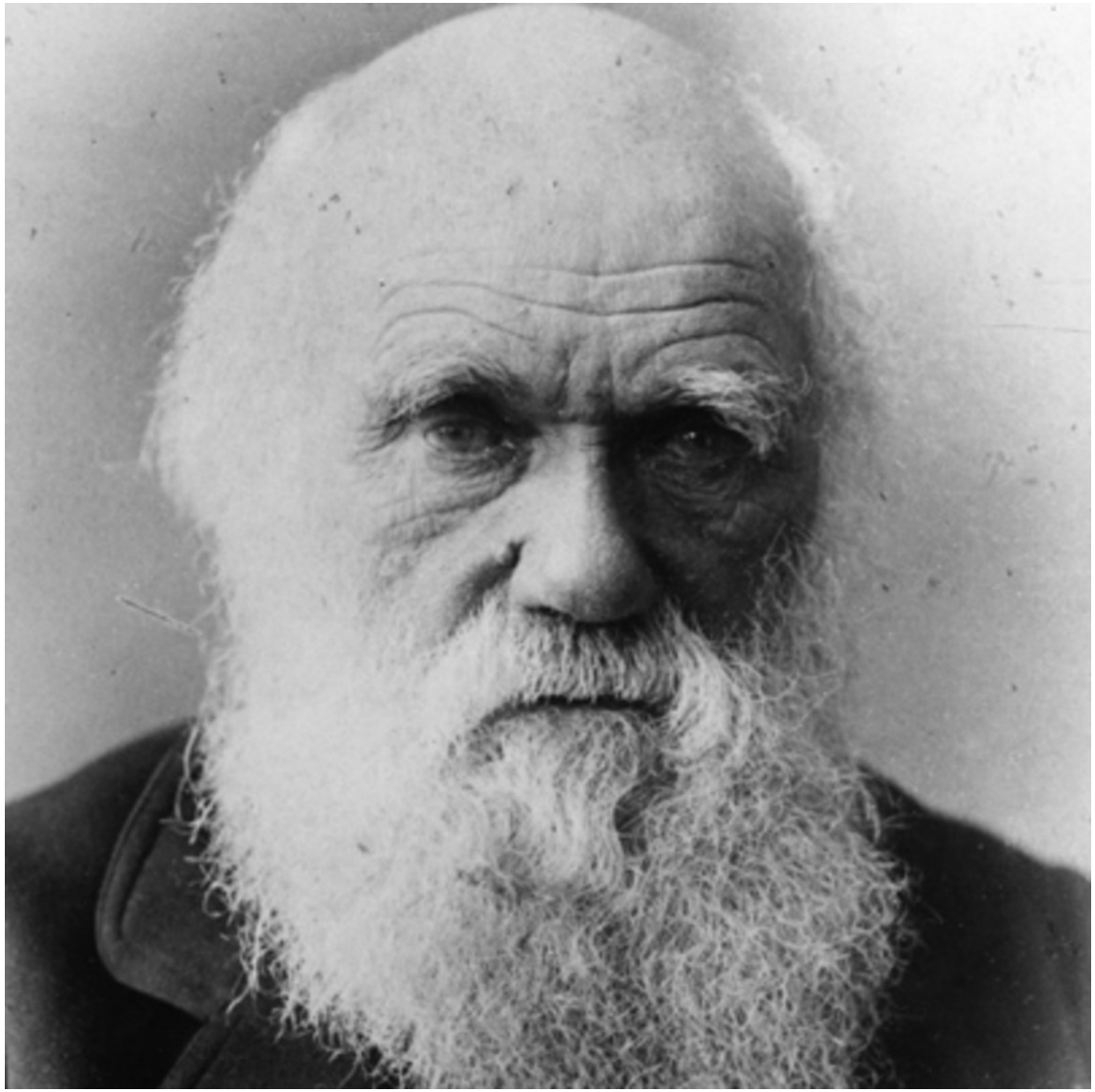
  - Stimulated the take-off from stagnation to growth

Charles Darwin



The Critical Impact of Malthus on Darwin

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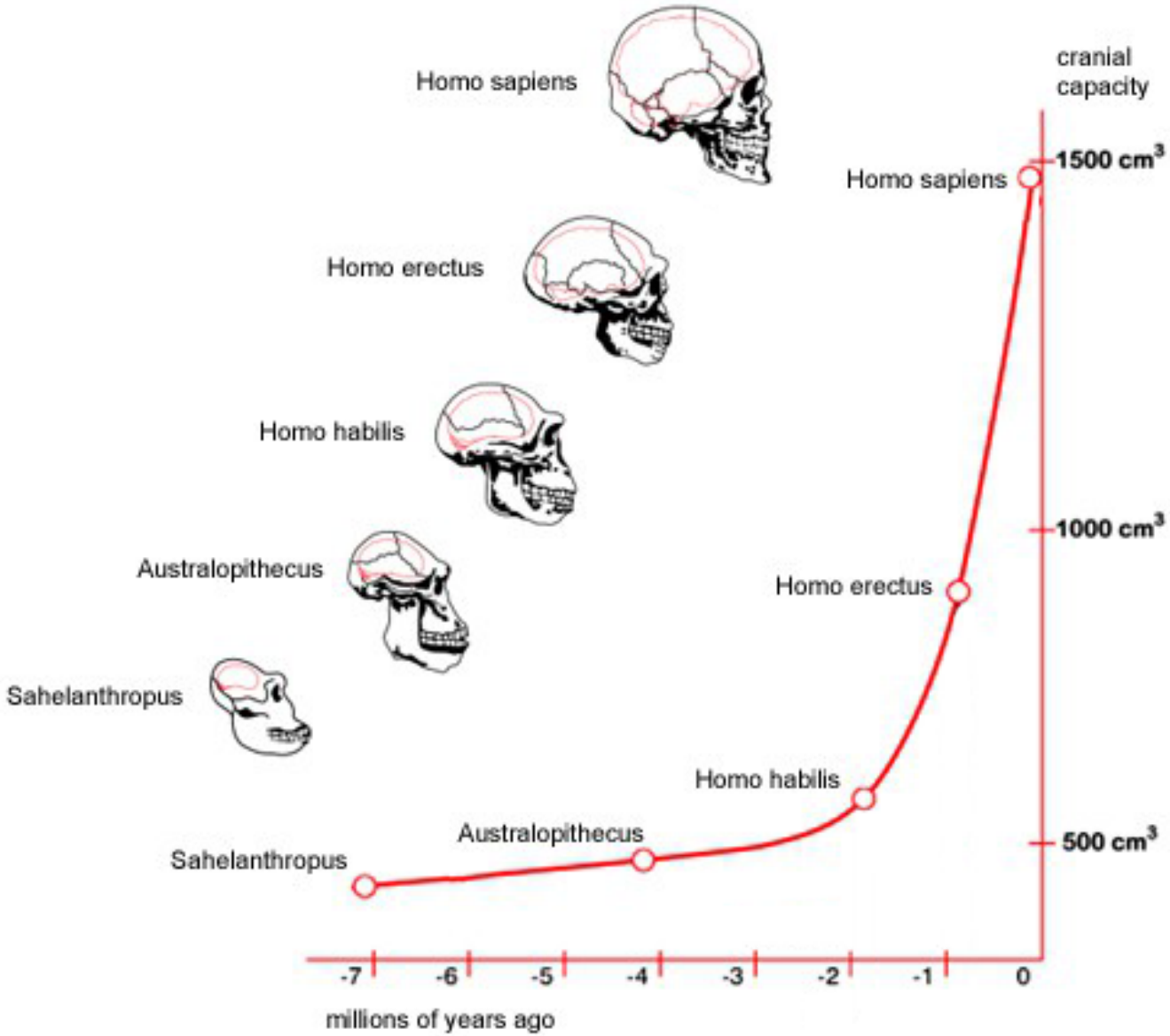
  - Darwin: Favorable traits will be selected
  - Galor-Moav: Among humans, complementary traits to the technological environment will be selected and they will contribute to technological change & the transition from stagnation to growth

Evolution of the Human Brain - Relative Volume & Size of Cerebral Cortex



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    - Convergent Evolution: vitals organs evolved in parallel path across species (i.e., eyes)

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  - Ability to conquer the environment & to become the masters of Earth

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    - Improved social standing via: persuasion & complements & lies & humor

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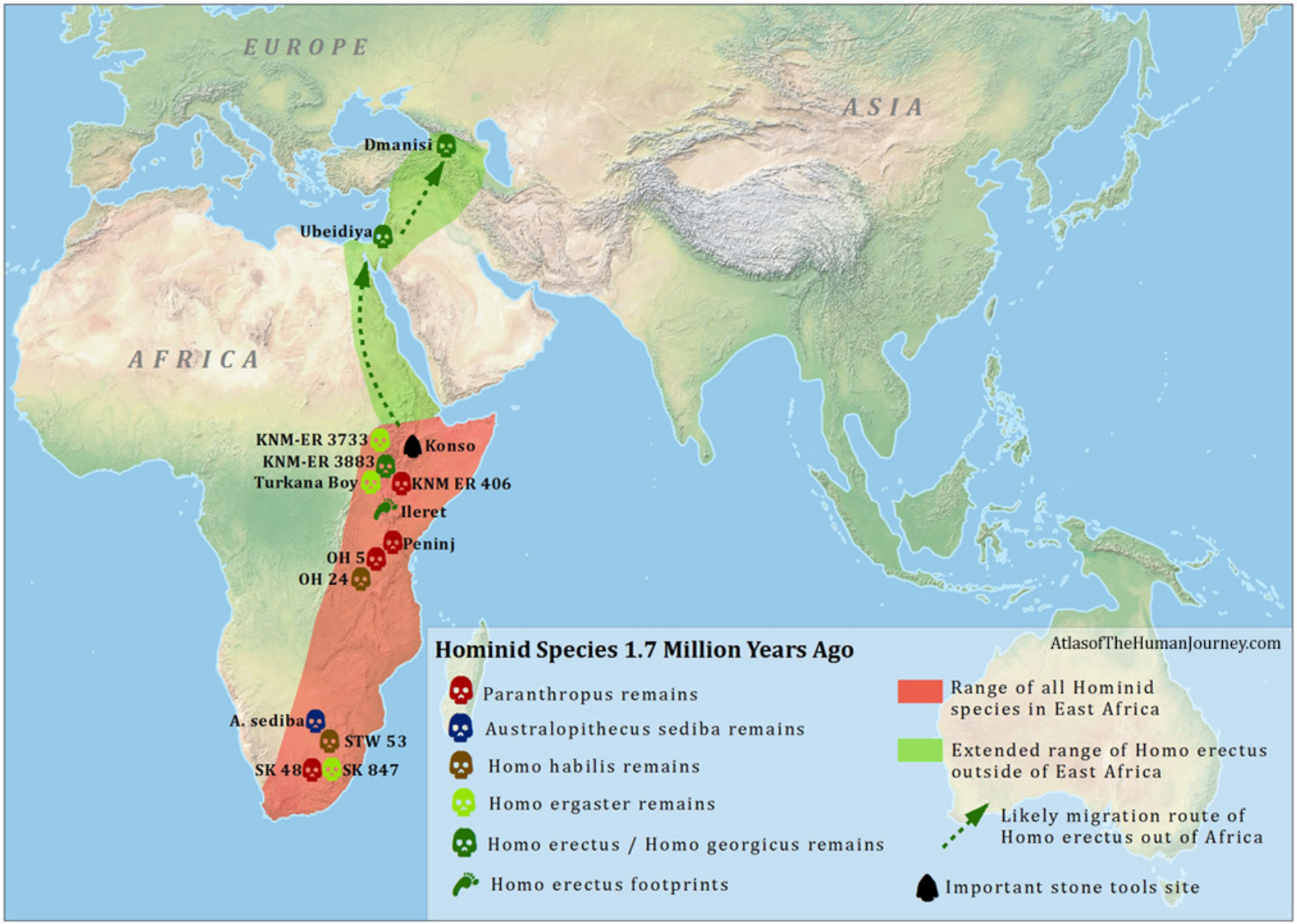
    - Inferring from the thought process about the qualities of the potential partner that may be important for the survival of their offspring

Out of Africa - Homo Erectus



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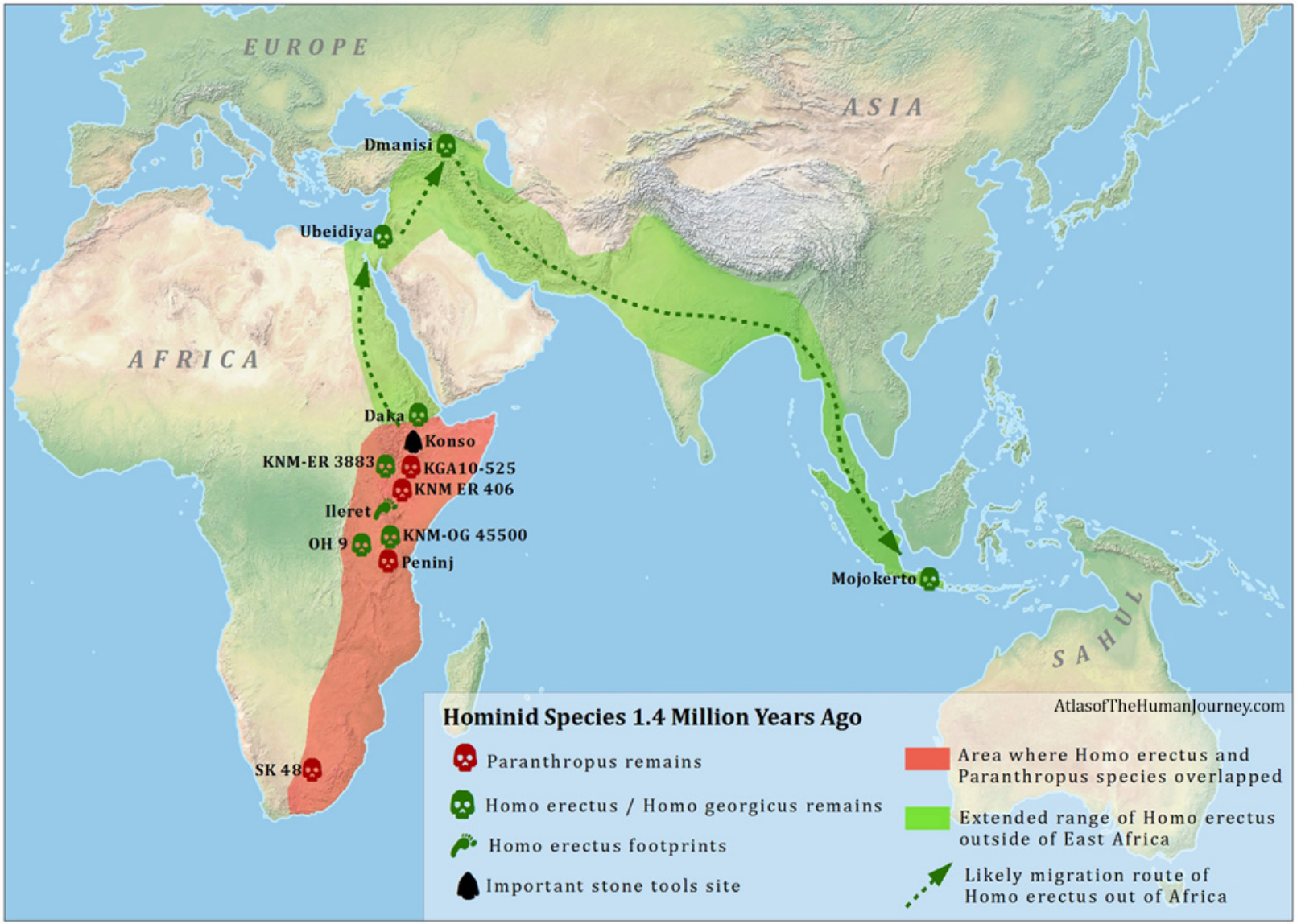

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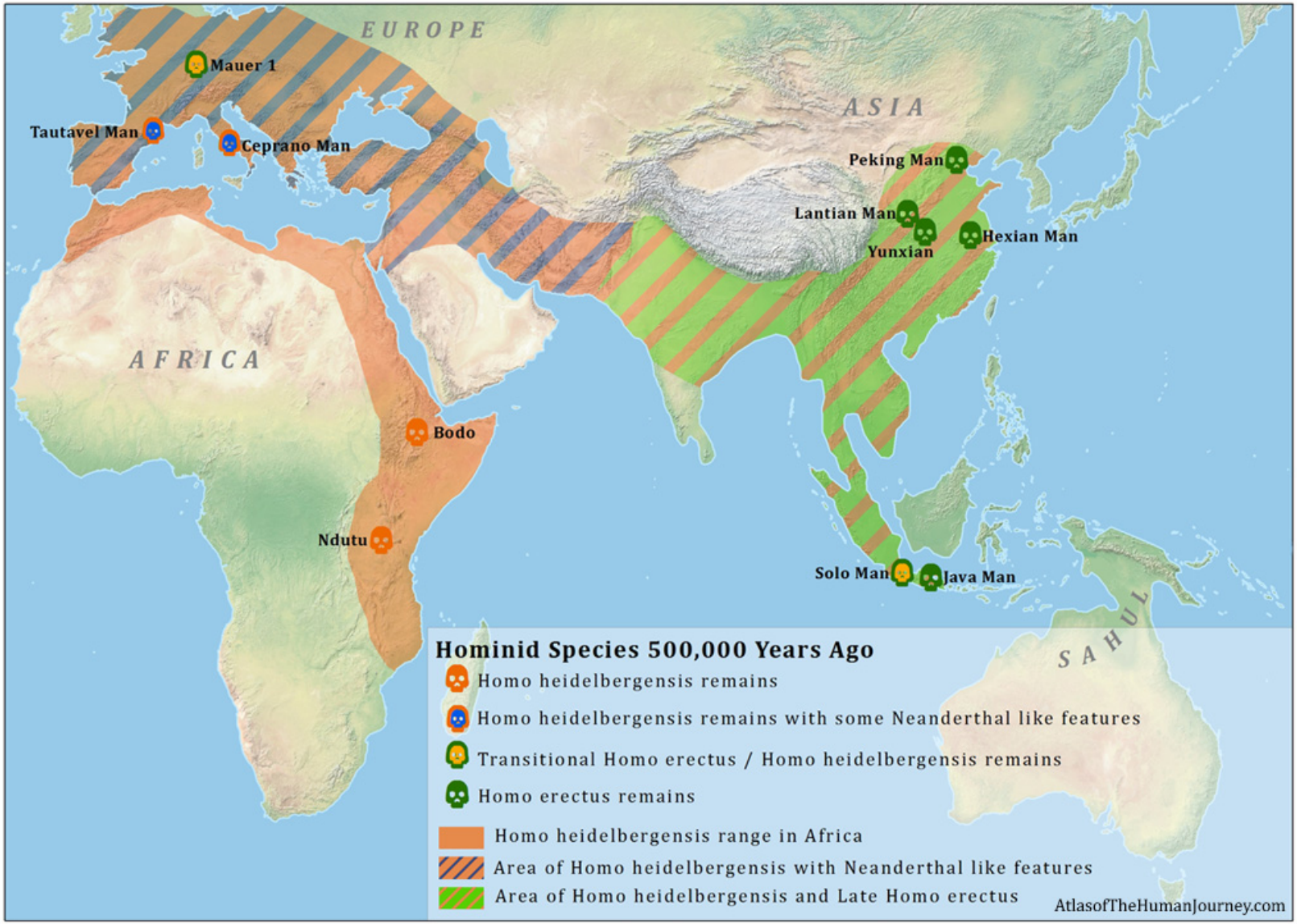
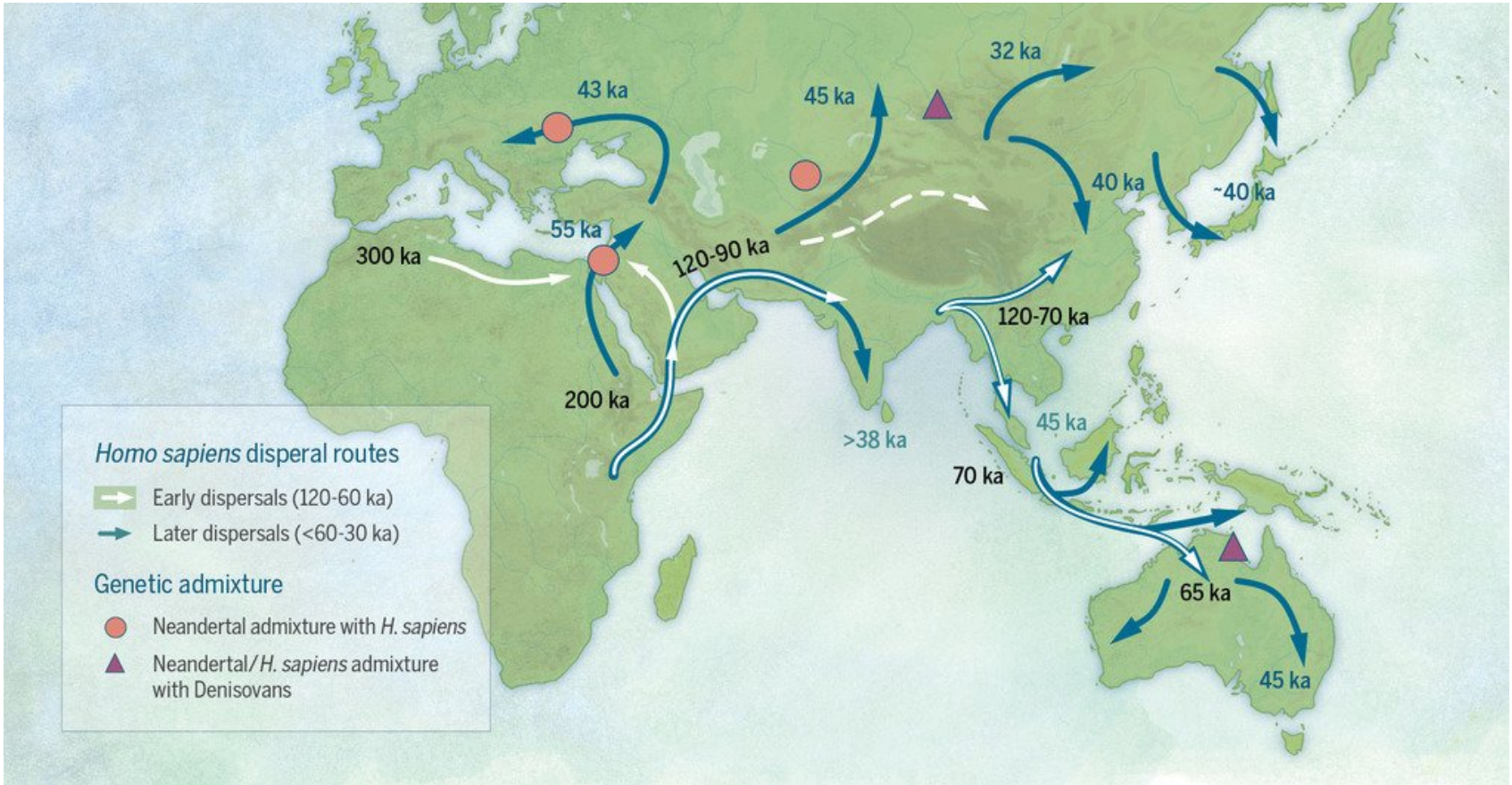


Out of Africa - Homo sapiens



Coevolution - Technology & Human Brain

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Nahal Me'arot - Tabun Cave

Nahal Me'arot - Gamal Cave

Nahal Me'arot - Animals

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Nahal Me'arot - Flint Tools

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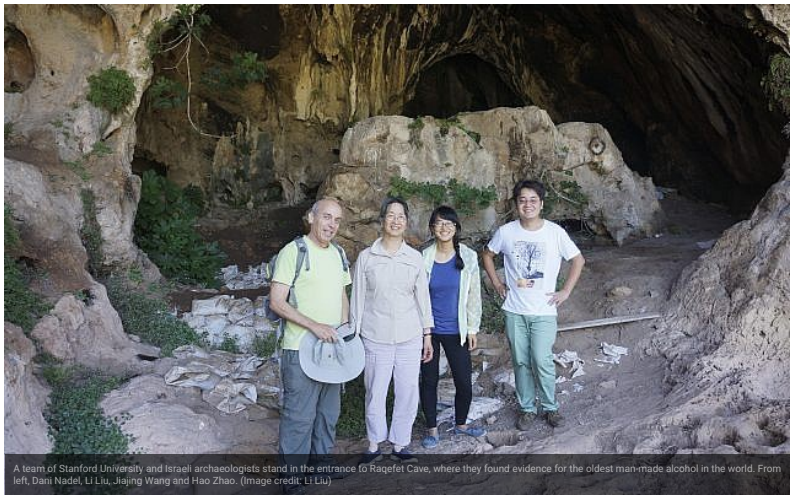
Oldest Bear Brewery - The Carmel Mountain Range

FIND PREDATES GRAIN CEREAL DOMESTICATION BY 4,000 YEARS

13,000-year-old brewery discovered in Israel, the oldest in the world

Ancient Natufians tamed seven species of wild grains for ancient ale, according to new Stanford University study

By AMANDA BORSCHEL-DAN
12 September 2018, 7:18 pm



A team of Stanford University and Israeli archaeologists stand in the entrance to Raqefet Cave, where they found evidence for the oldest man-made alcohol in the world. From left, Dani Nadel, Li Liu, Jiajing Wang and Hao Zhao. (Image credit: Li Liu)

1 2 3 4 5

Which came first: beer or bread production? The 60-year-old archaeological debate is coming to a (frothy) head as a new Stanford University study of three 13,000-year-old stone mortars offers the earliest known physical evidence of an extensive ancient beer-brewing operation.

An international team of scientists discovered and tested residue from the mortars, which were used by the semi-nomadic Natufians and discovered near a graveyard site called the Raqefet Cave, in the Carmel Mountains near Haifa, Israel, according to a Stanford News article on the discovery. The Natufians lived in the Levant between the Paleolithic and the Neolithic periods.

The find comes on the heels of a July report that archaeologists working in northeastern Jordan discovered the charred remains of bread baked by Natufians some 11,600 to 14,600 years ago. According to the Stanford scientists, the ancient beer residue comes from 11,700 to 13,700 years old, potentially predating the bread.

Regardless of which came first, both the brewery and the bread production precede evidence of domesticated cereals in the Levant, which arrived some 4,000 years later.

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- Steady evolution of the volume of the human brain

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    - Enlarging the brain on the account of the jaw and its muscles

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  - Development of wooden spears & sharp stones
- Evolution of human traits
  - Selection of good throwers

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    - Entrepreneurial spirit (Galor-Michalopoulos, JET 2012)

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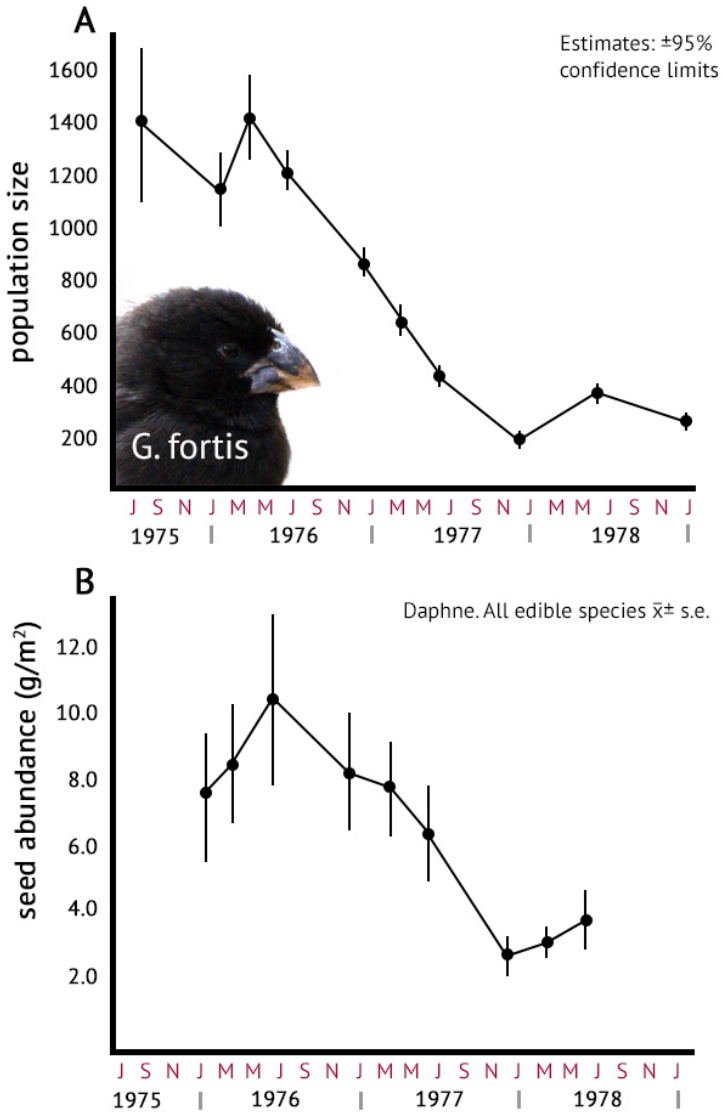
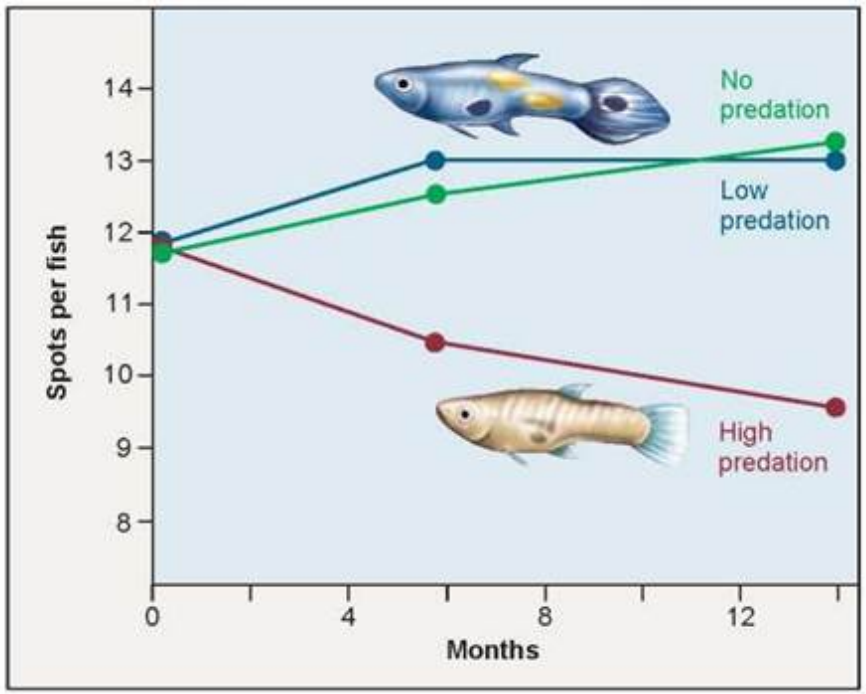


Rapid Evolution in Guppies



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  - Strong positive selection since the Neolithic transition (Mathieson et al., 2015)

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- 2 factors of production:
  - Labor (measured in efficiency units)
  - Land

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- Efficiency units of labor evolves endogenously
  - Determined by households' decisions about the number and level of human capital of their children

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- Output per capita fluctuates (with a negligible trend) around a constant level in the long-run
  - Reflecting diminishing returns to labor & positive effect of income on population

Production

- The output produced in period t

$$Y_t = H_t^{1-\alpha}(A_t X)^{\alpha}$$

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- Output per efficiency units of labor at time t

$$y_t = x_t^{\alpha}$$

  - $x_t \equiv (A_t X)/H_t \equiv$ effective resources per worker

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- Long-run (population reaches a new steady-state):
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Sources of Technological Progress

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  - human capital provides an advantage in adopting and advancing new technologies

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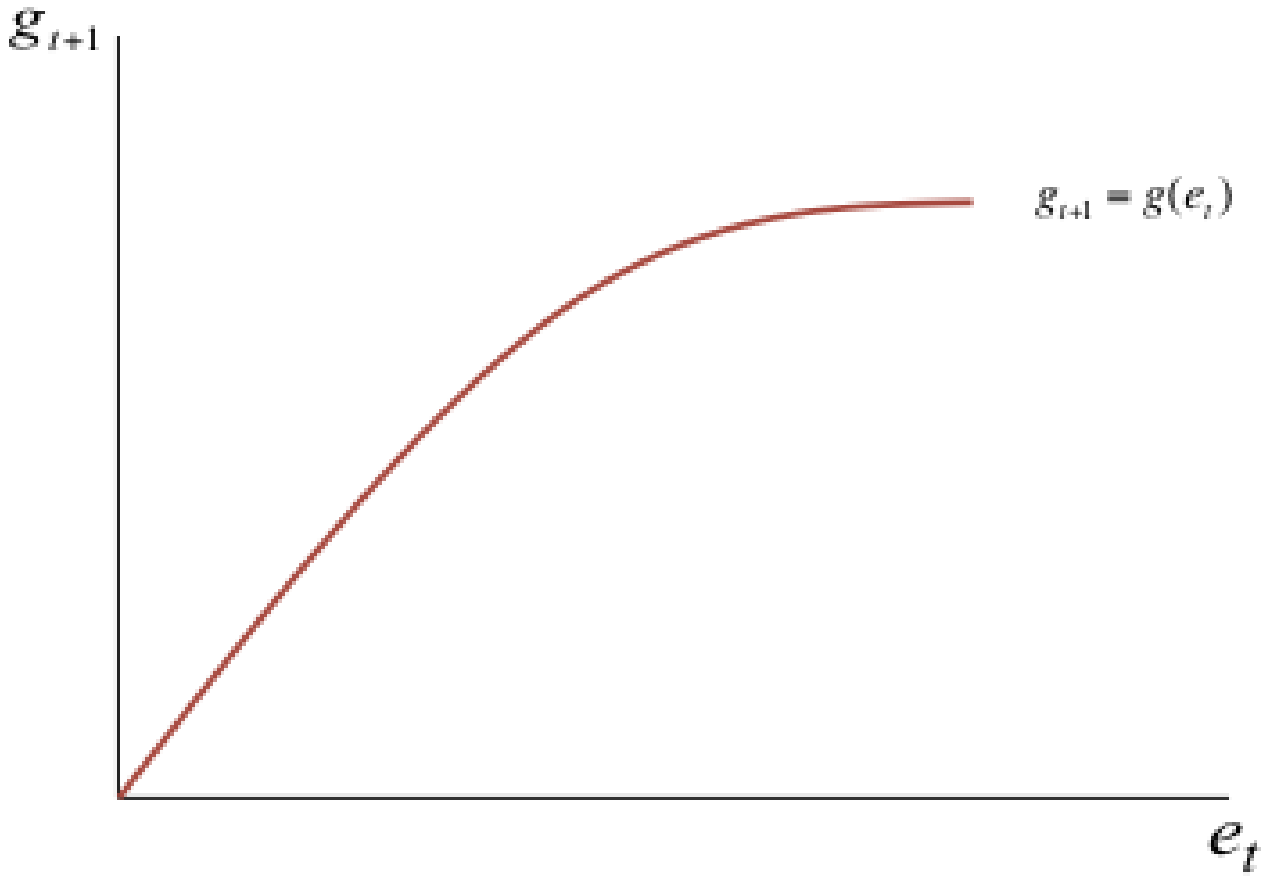
$$\psi'(e_t) > 0; \quad \psi''(e_t) < 0; \quad \psi(0) = 0$$

  - The average quality of the population has a positive and diminishing effect on technological progress

Technological Progress



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  - Human capital permits individuals to better cope with the changes in the technological environment
  - The introduction of new technologies is skill-biased in the short-run, although the nature of the technology can be skill-biased or skill-saving in the long run

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Human capital of an individual who joins the labor force in period $t+1$

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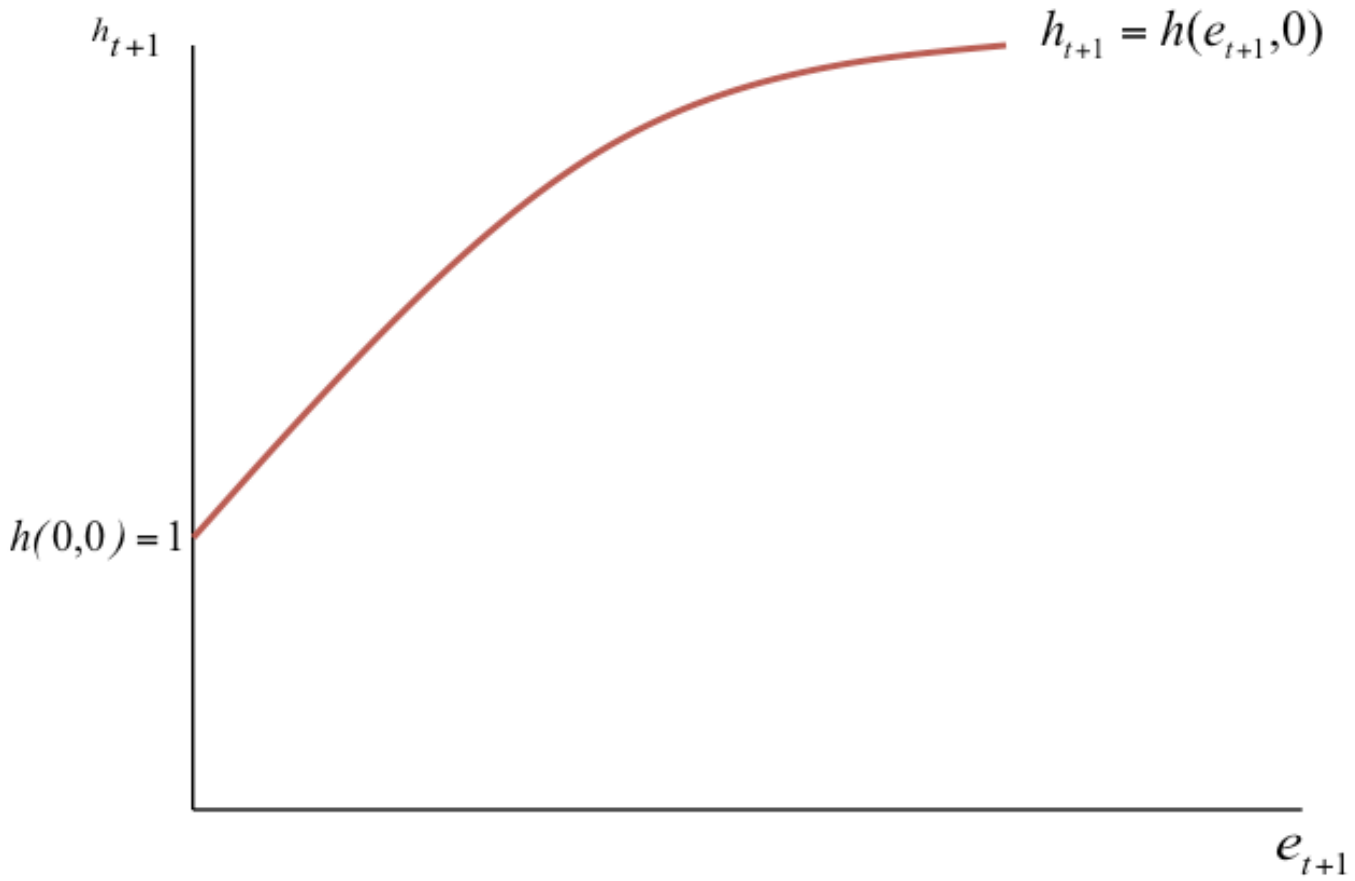
  - Basic level of human capital

Human Capital Formation



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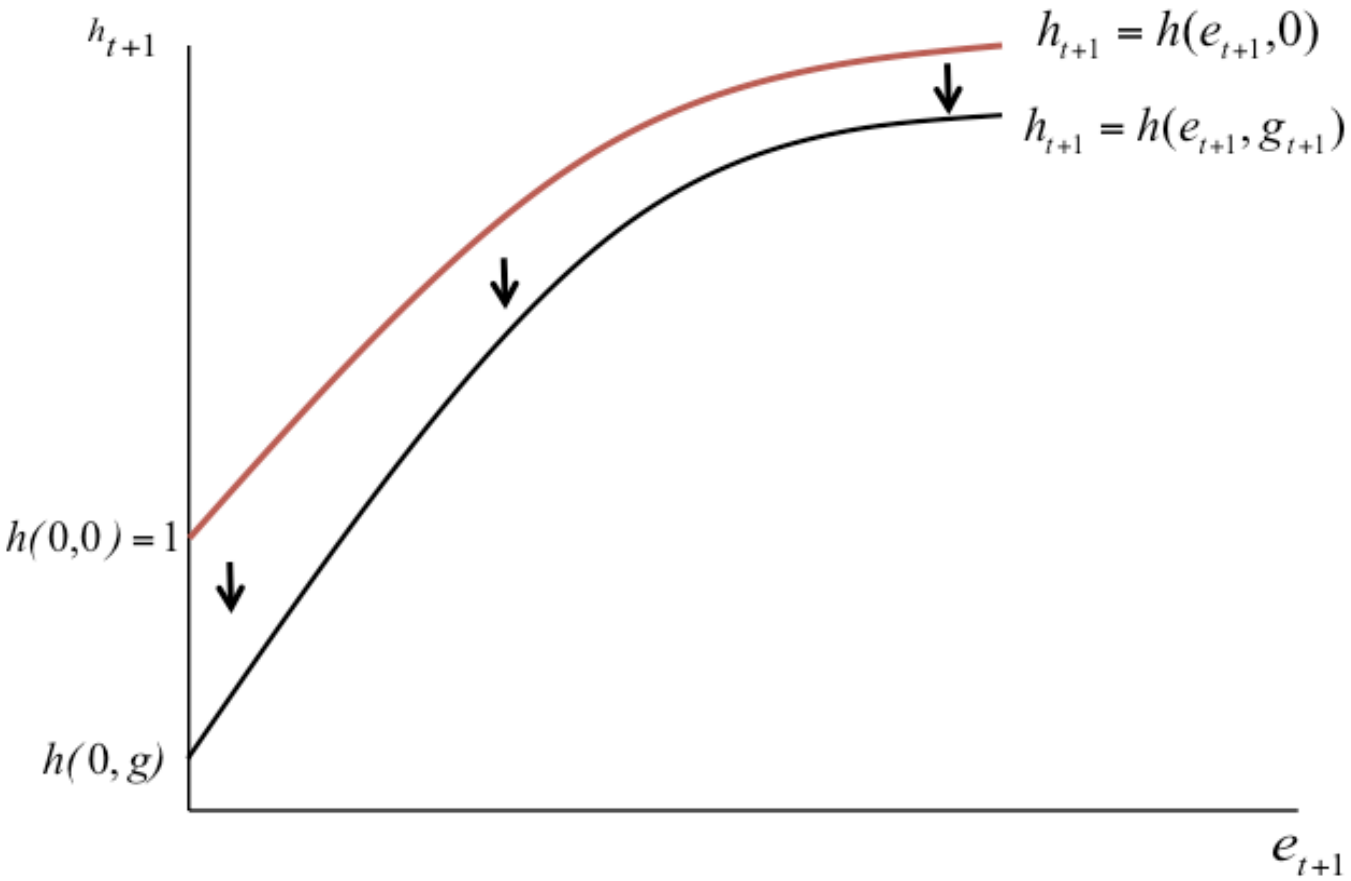

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  - $h_{t+1}^i \equiv$ human capital of each child of member i of generation t
  - $\beta^i \equiv$ predisposition towards quality of individual of type i

Preferences

- The utility function of a member i of generation t (adults at time t)

$$u_t^i = (1-\gamma)\ln c_t^i + \gamma[\ln n_t^i + \beta^i \ln h_{t+1}^i]$$

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- Intergenerational transmission of predisposition towards quality

$$\beta_{t+1}^i = \beta_t^i = \beta^i$$

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    - Consumption above subsistence assure that survival of the parent & lineage

Budget and Subsistence Consumption Constraints

$$w_t h_t^i n_t^i (\tau + e_{t+1}^i) + c_t^i \leq w_t h_t^i \equiv z_t^i$$

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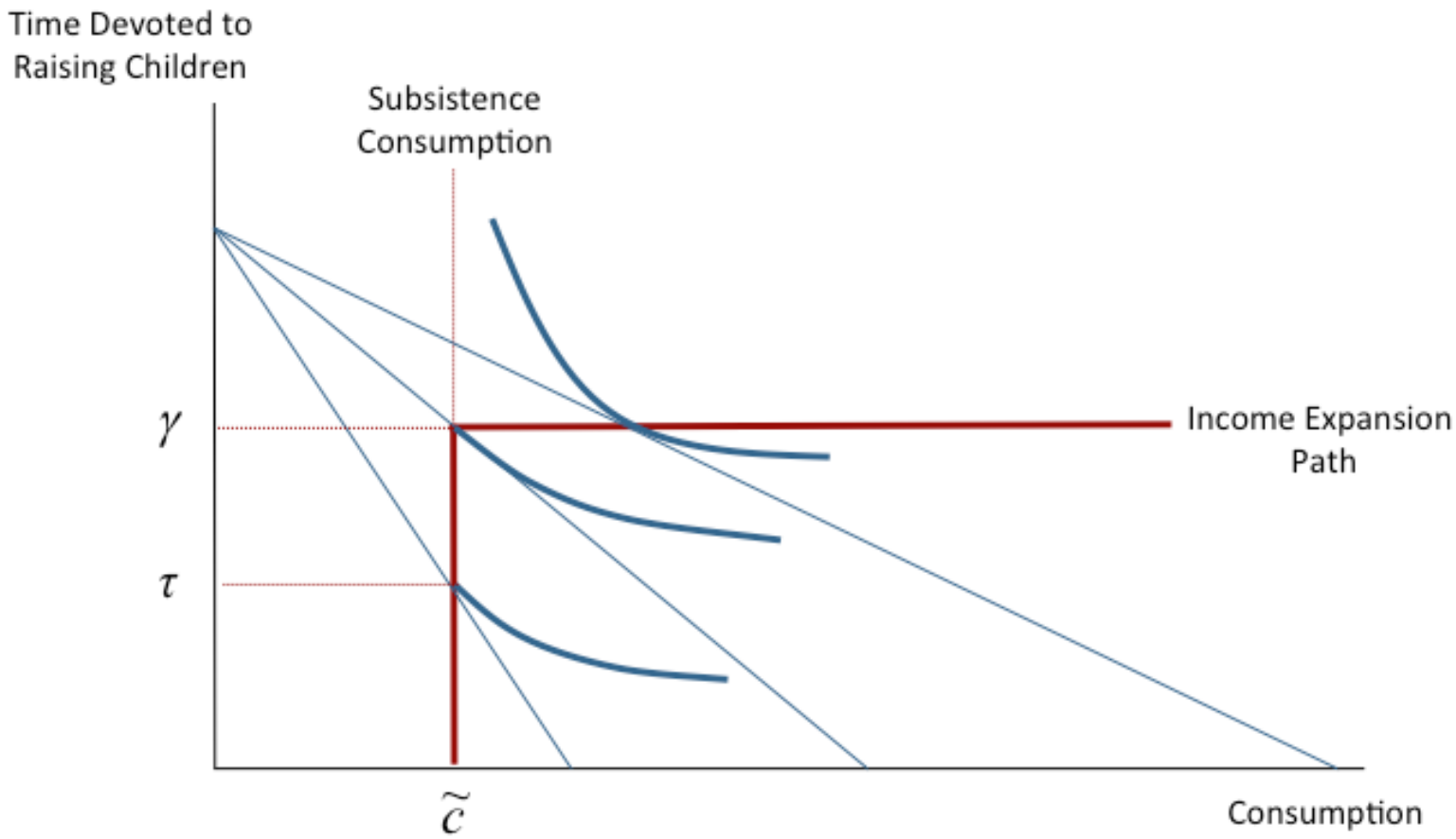
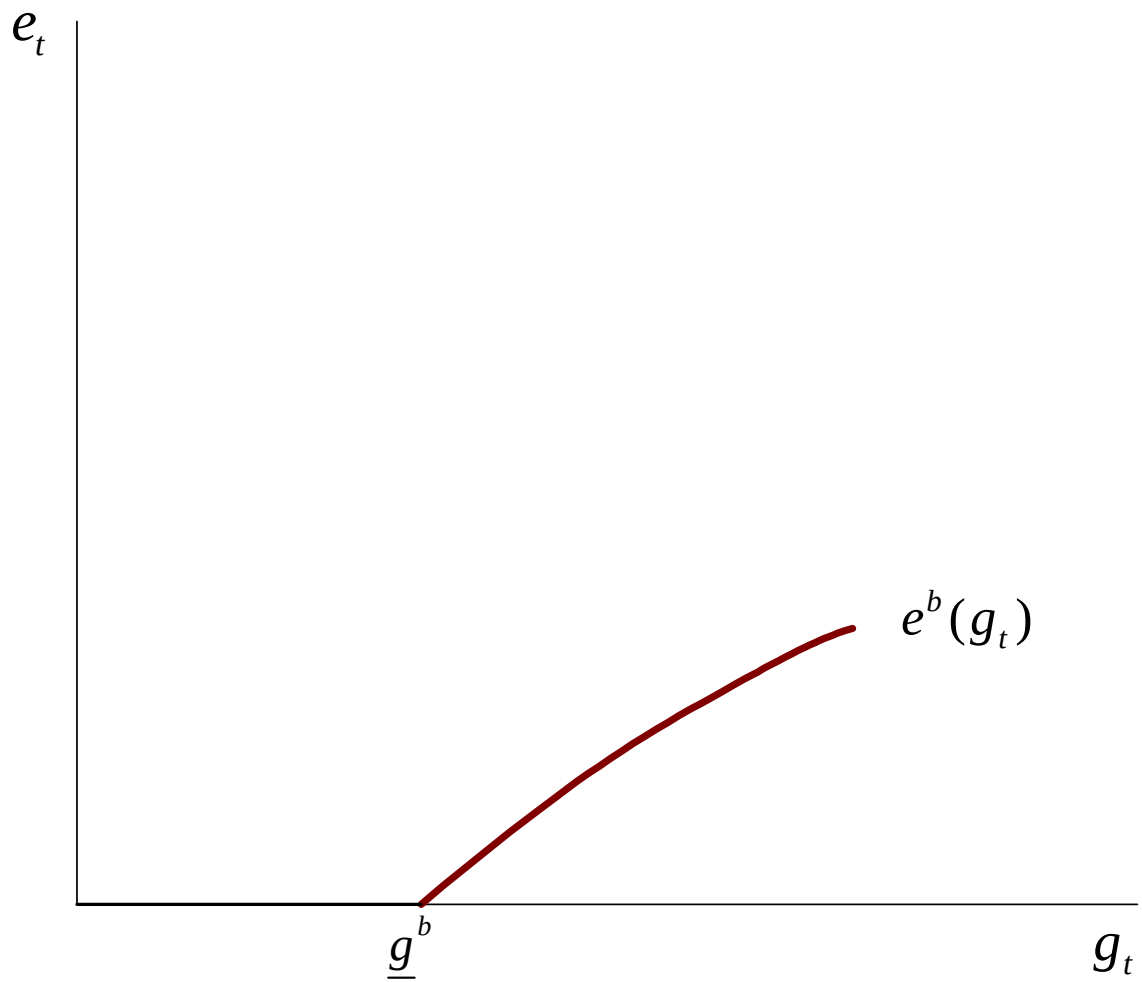
- Subsistence consumption constraint:

$$c_t \geq \tilde{c}$$

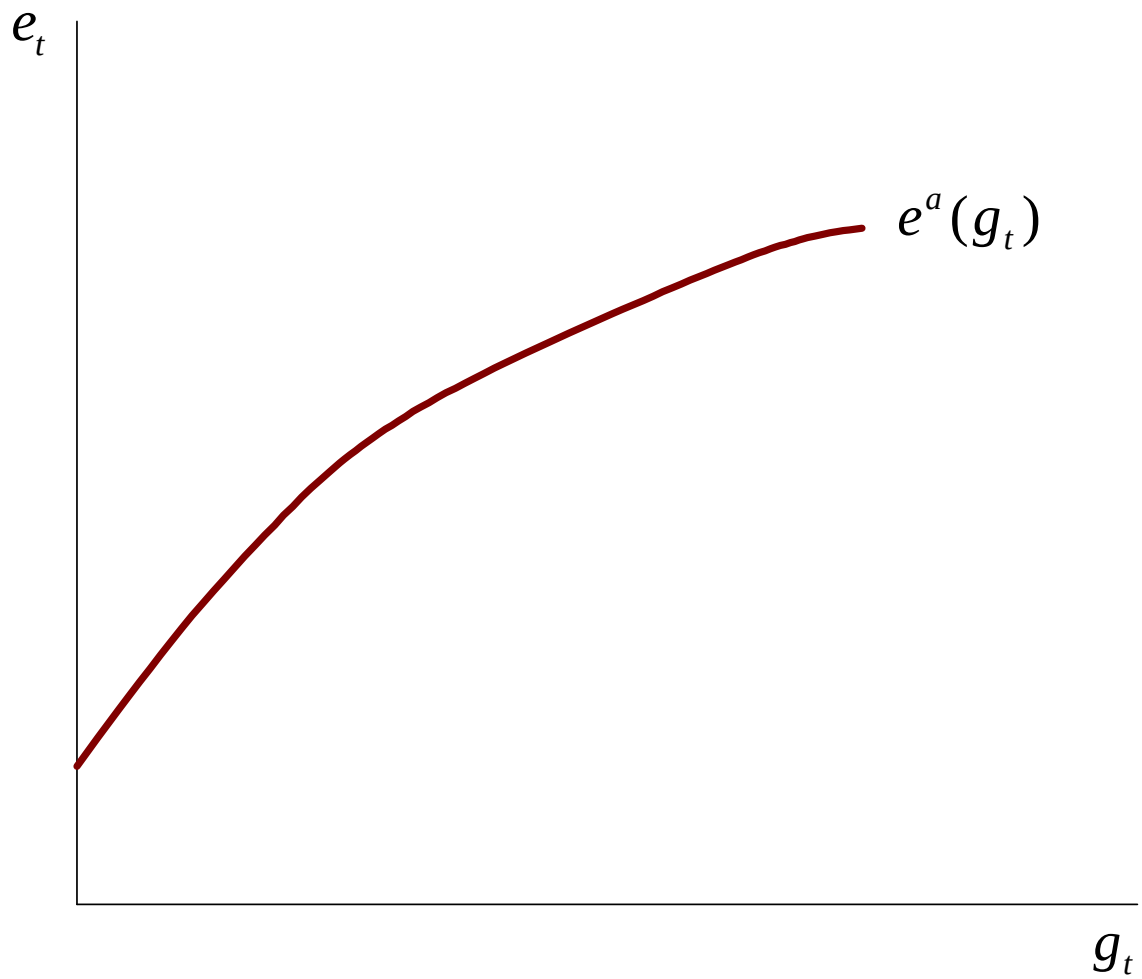
Constraint and Optimization



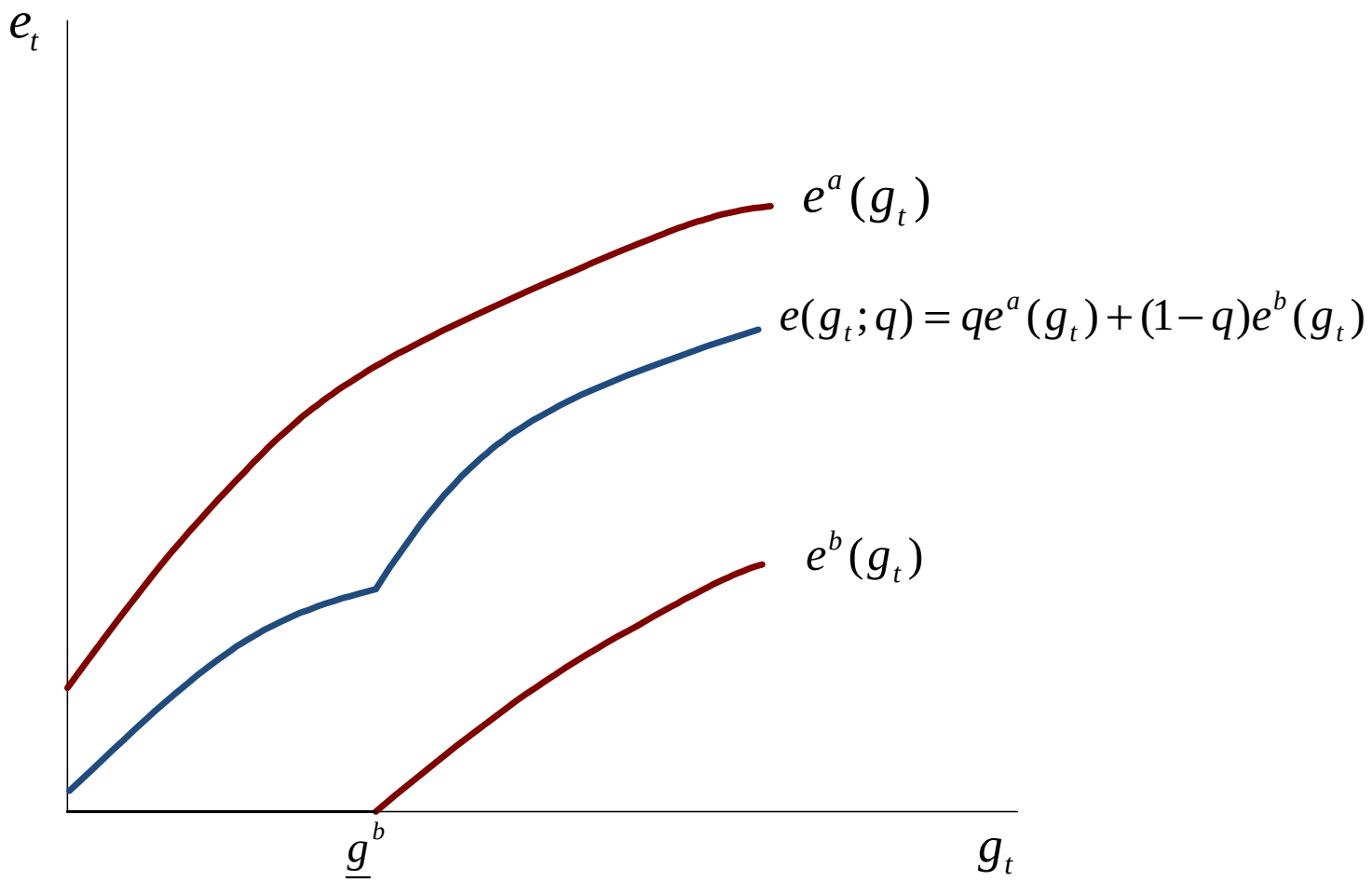
Optimal Investment in Child Quality of the Qantity type



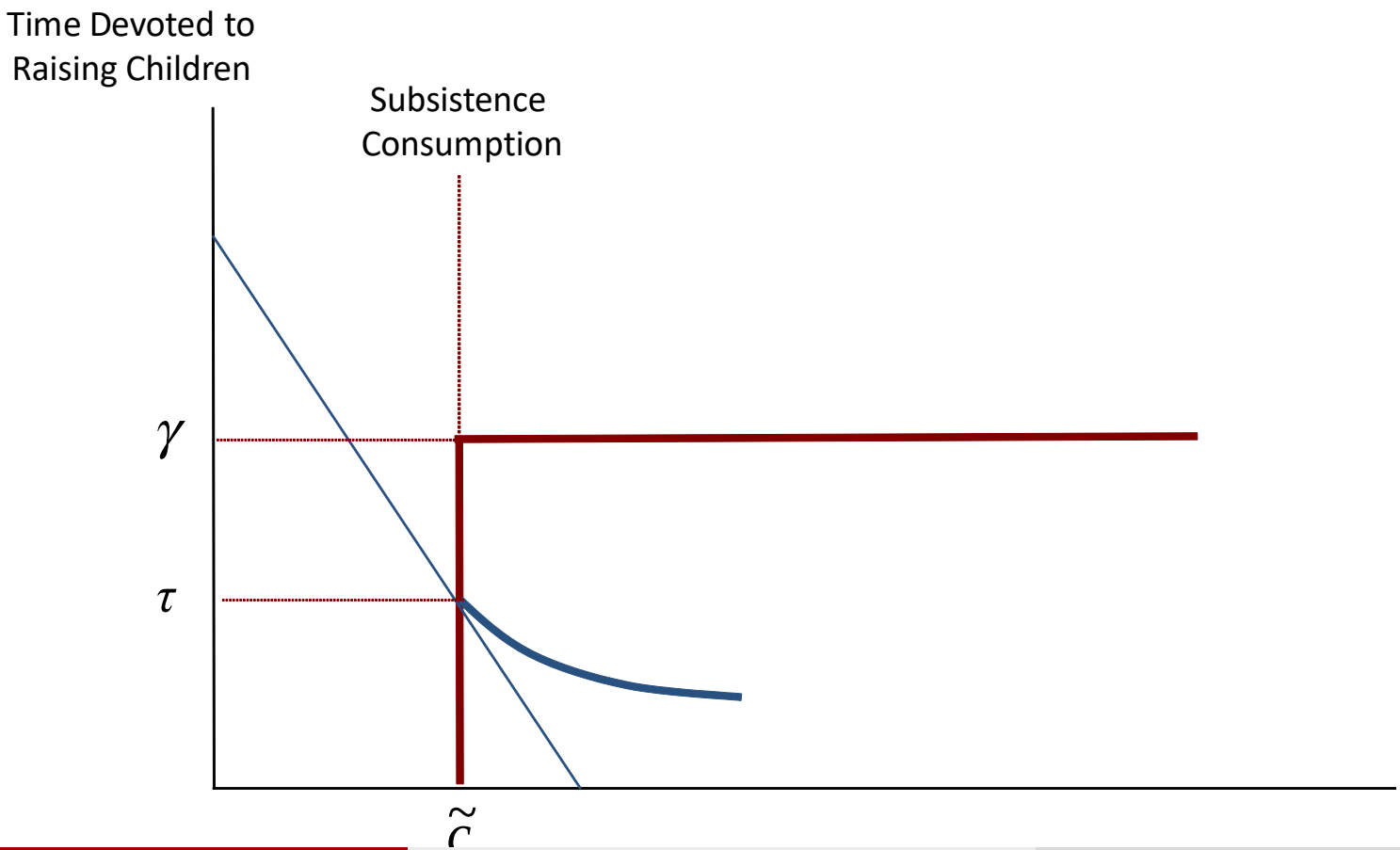
Optimal Investment in Child Quality of the Quality type



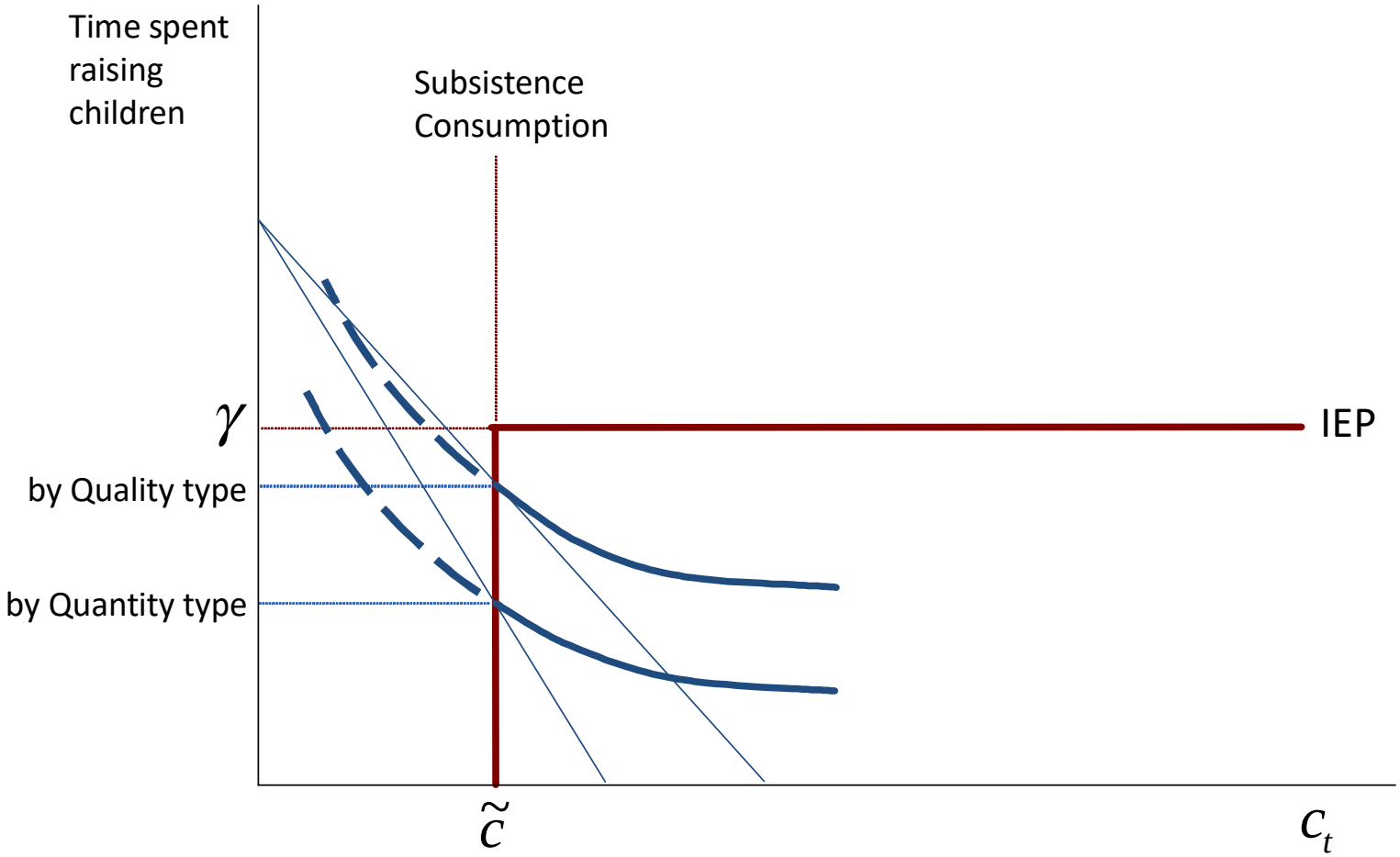
Optimal Investment in Child Quality - Quality type - and Qantity type



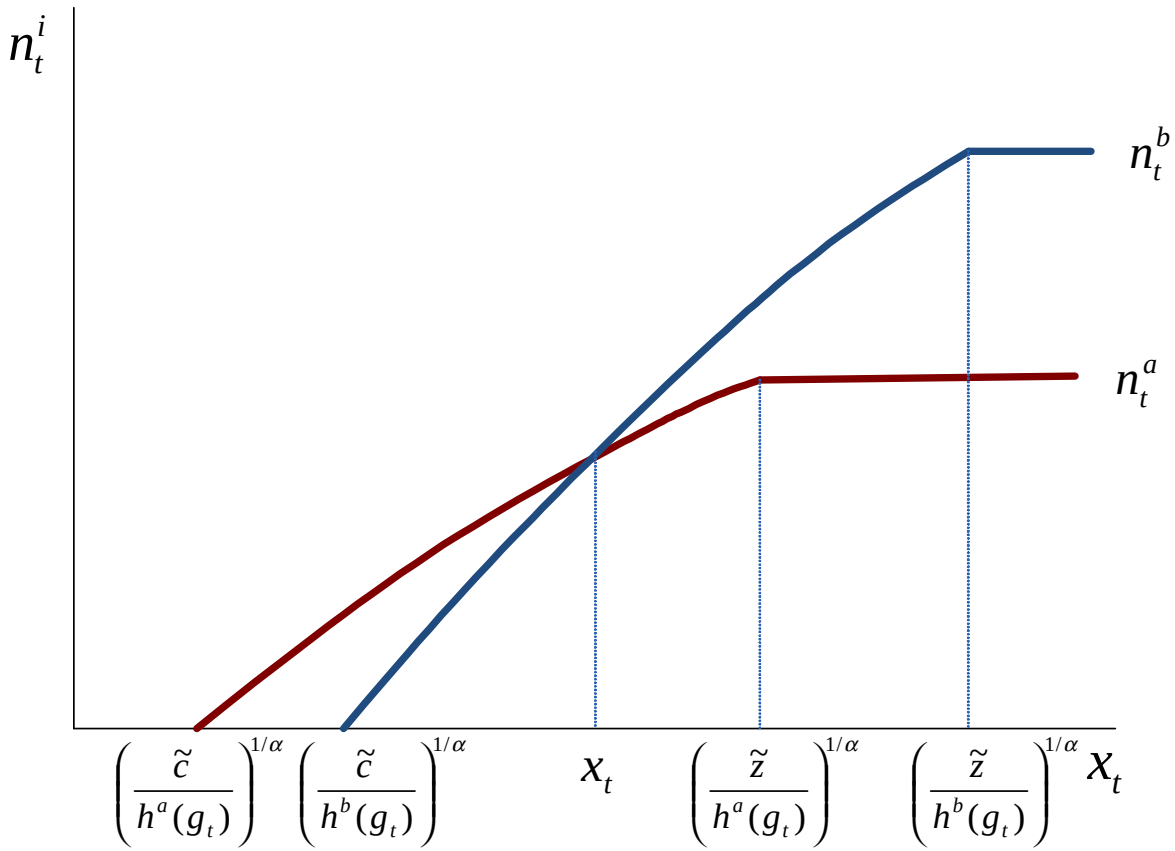
Optimization – Malthusian Epoch



Evolutionary Advantage of the Quality Type



Differential Fertlity Across Types



The Dynamical System

A sequence $\{x_t, g_t, e_t, q_t\}_{t=0}^{\infty}$ such that:

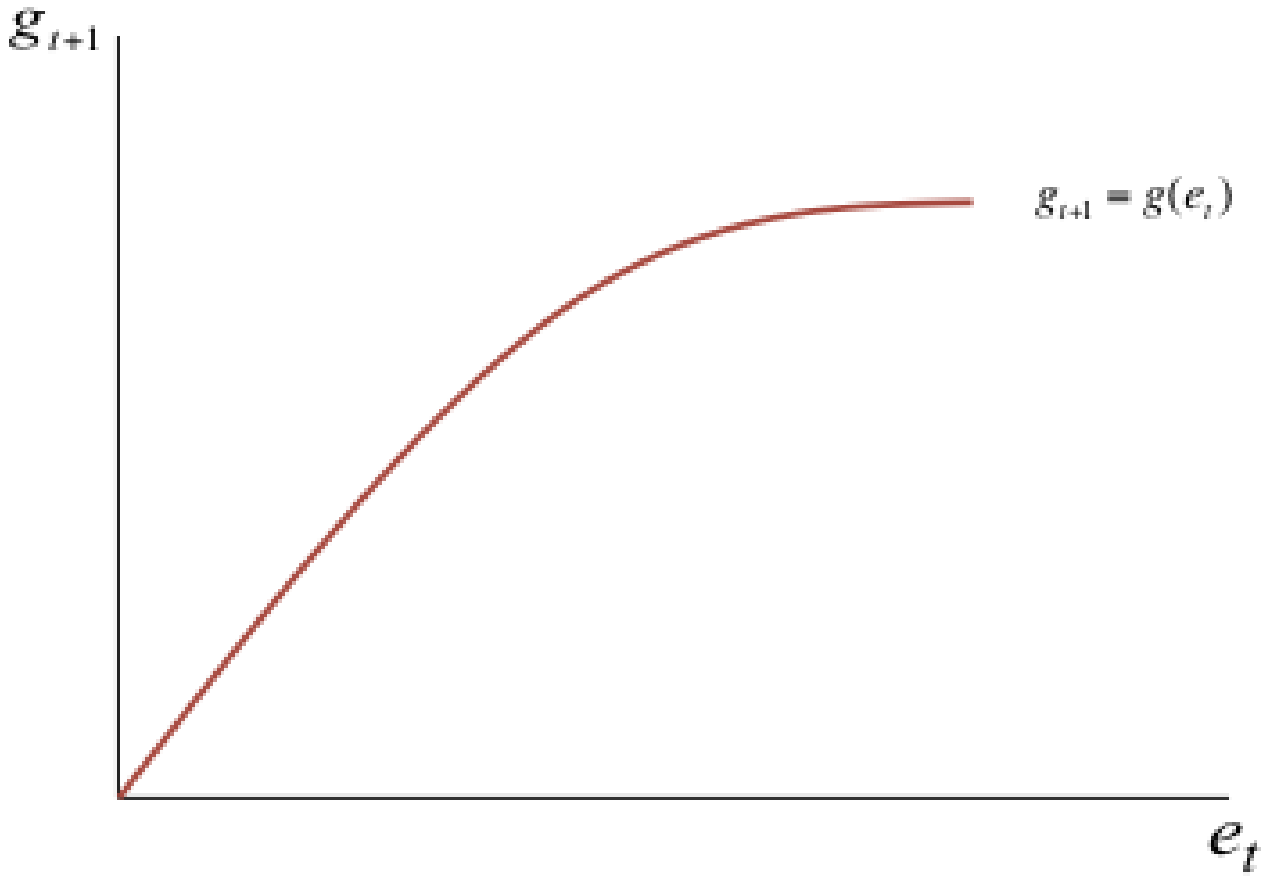
$$\begin{cases} x_{t+1} = x(g_t, x_t, q_t) \\ q_{t+1} = q(g_t, x_t, q_t) \\ g_{t+1} = \psi(e_t) \\ e_t = e(g_t, q_t) \end{cases}$$

The Conditional Evolution of Technology and Education

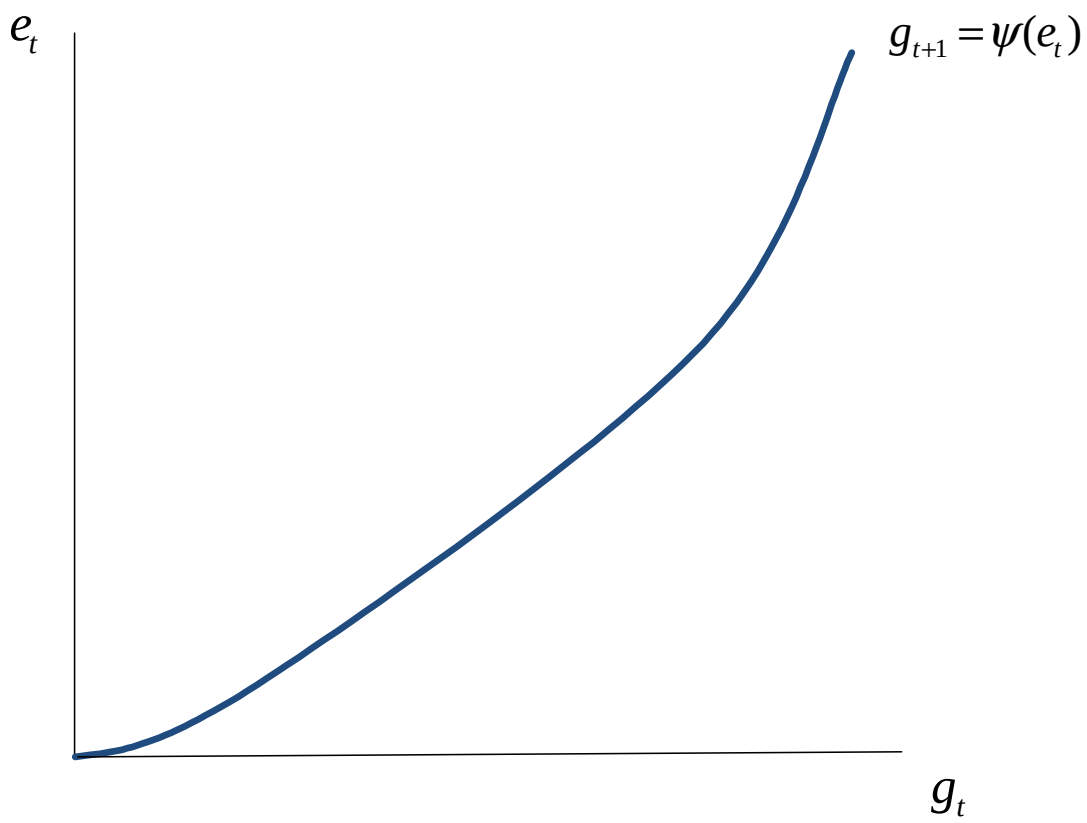
$\{g_t, e_t; q\}_{t=0}^{\infty}$ such that for all t

$$\begin{cases} e_t = e(g_t; q) \\ g_{t+1} = \psi(e_t). \end{cases}$$

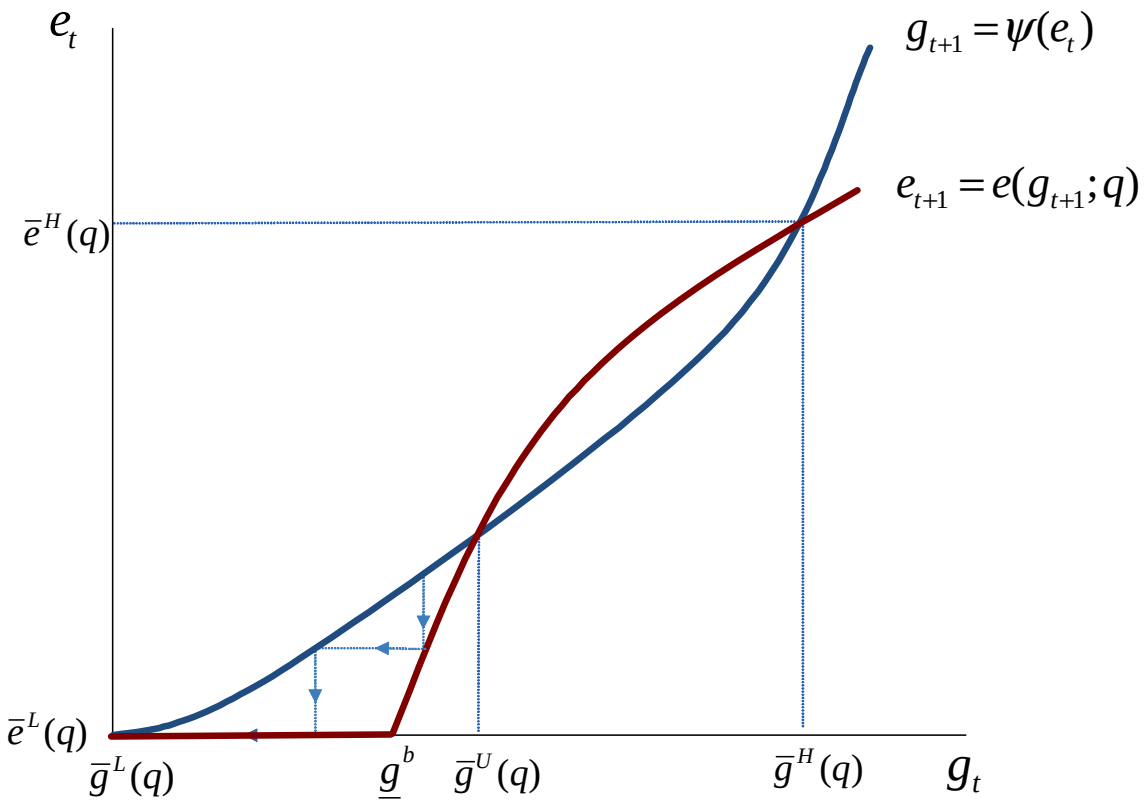
Technological Progress



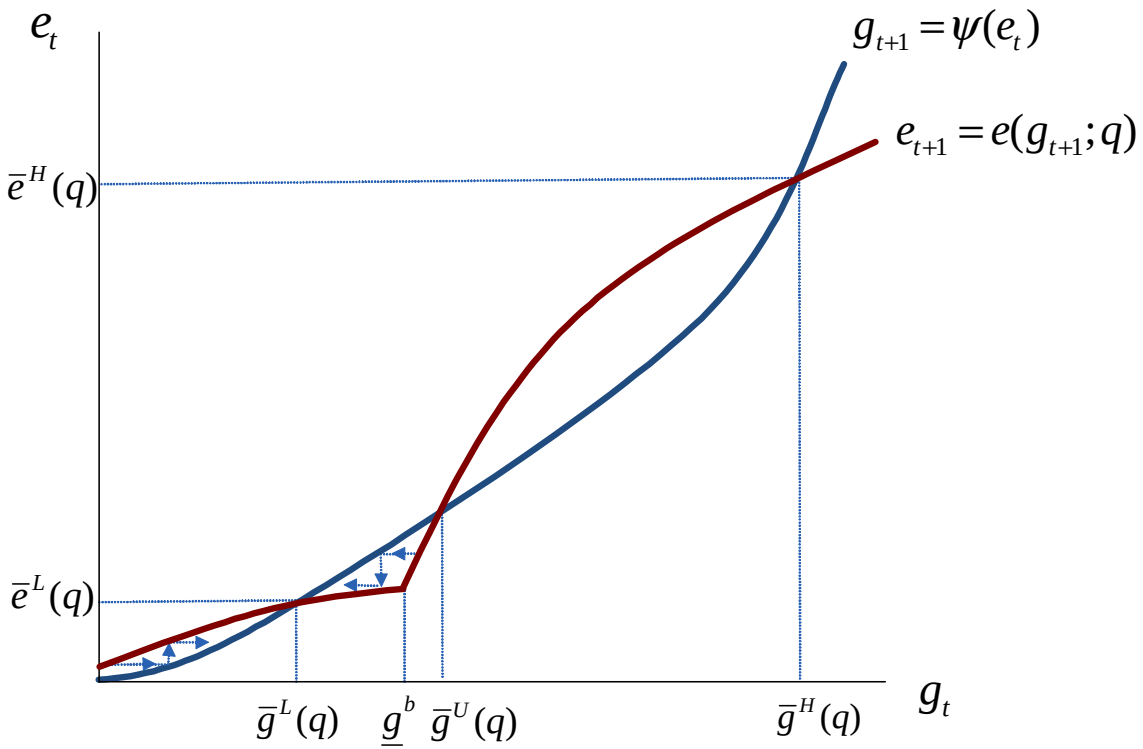
Technological Progress



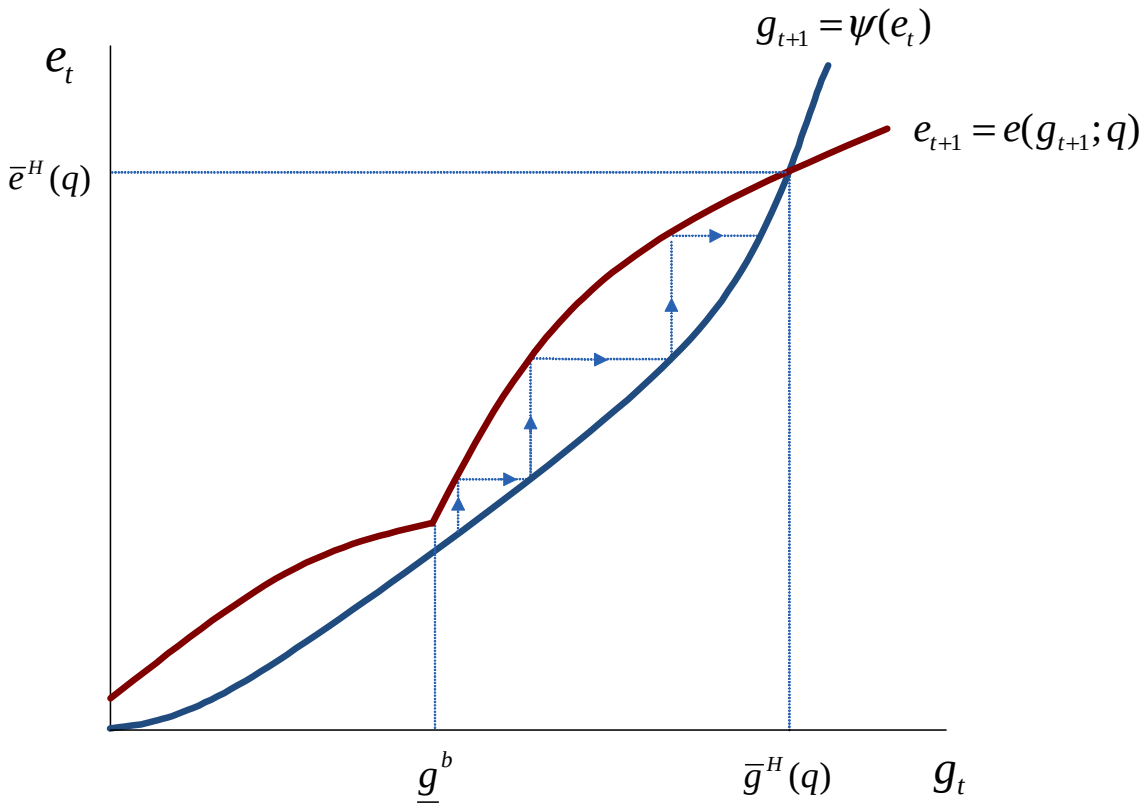
The Evolution of Education and Technology: The Fraction of the Quality Type q=0



The Evolution of Education and Technology: The Fraction of the Quality Type q>0



The Evolution of Education and Technology: The Fraction of the Quality Type is Above the Threshold



The Evolution of the Quality Type and TFP Growth