Adaptation & The Development Process

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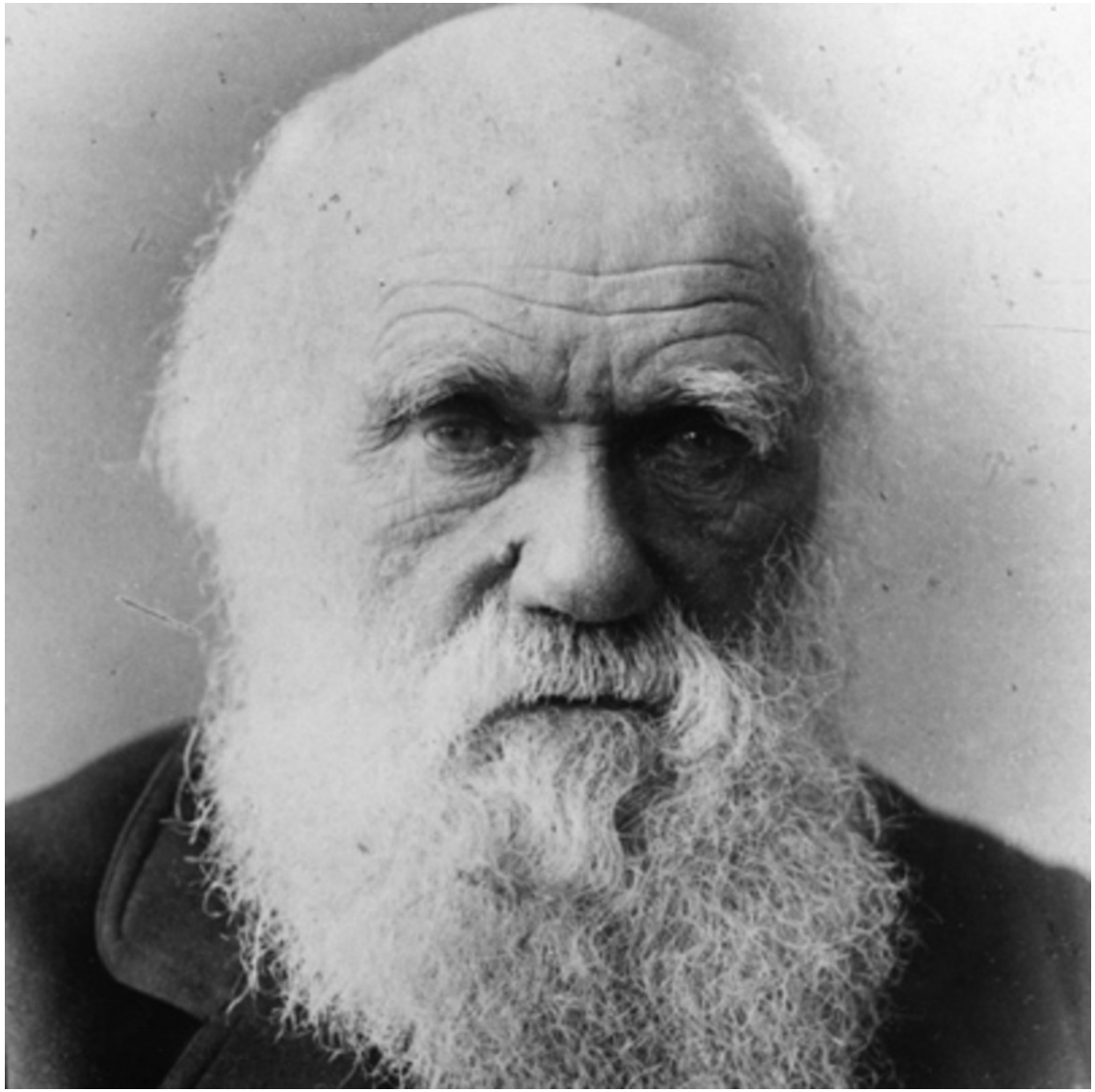
Charles Darwin (1809-1882)



The Critical Impact of Malthus on Darwin

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  - Yet, Darwin did not envision the impact of this adaptation on the (technological) environment

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    - Yet biological adaptation is viable too

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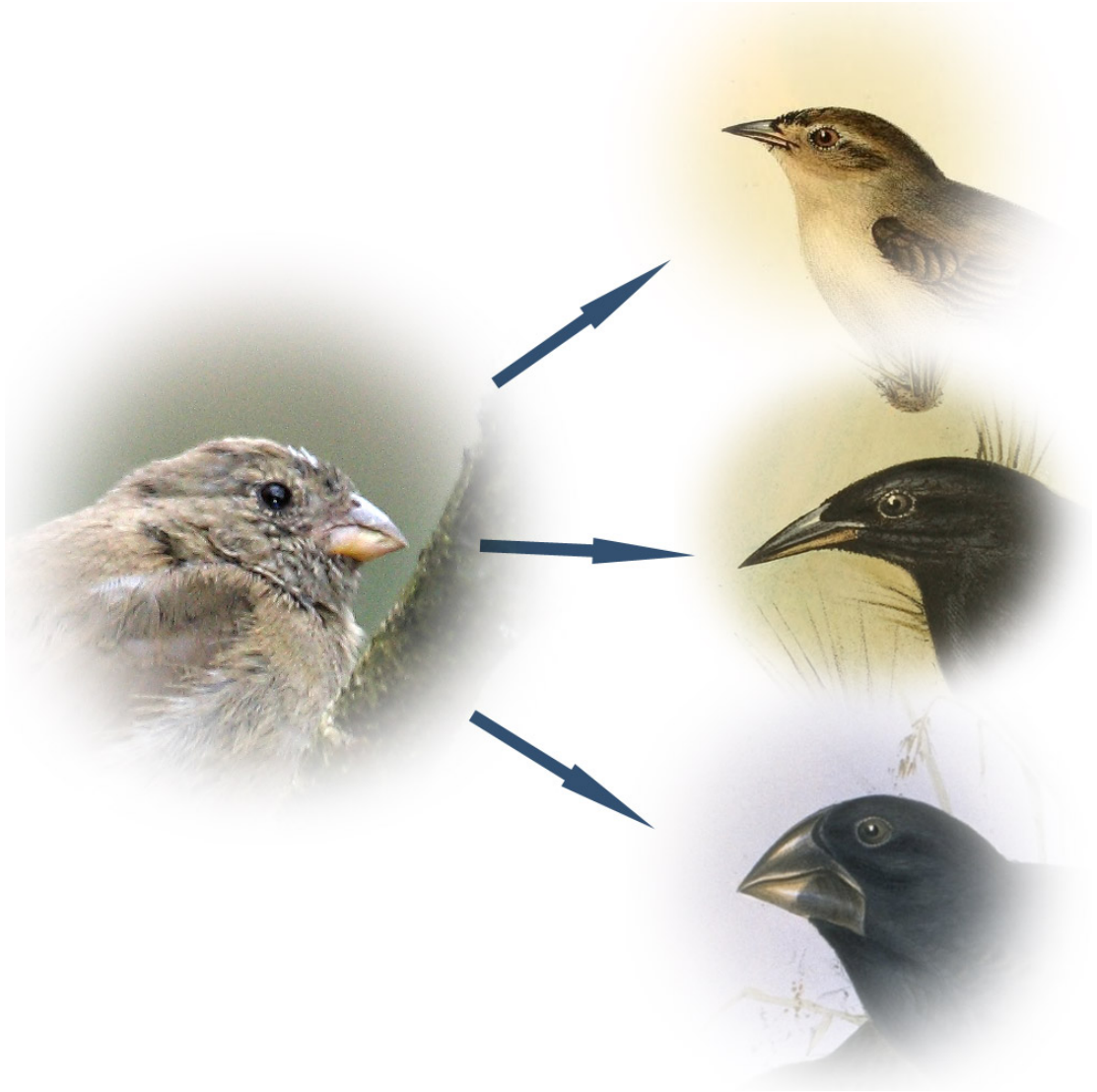
    - Trade-off: attracting sexual mates & predators

Rapid Evolution of the English Peppered Moth

Rapid Evolution Darwin's Finches Composition - Daphne Major, Galápagos



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Rapid Evolution the Composition of Guppies Triggered by New Predators

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- Intensification of the immune system & pigmentation
  - Variations reflect the timing of the Neolithic transition (Mathieson et al., 2015)

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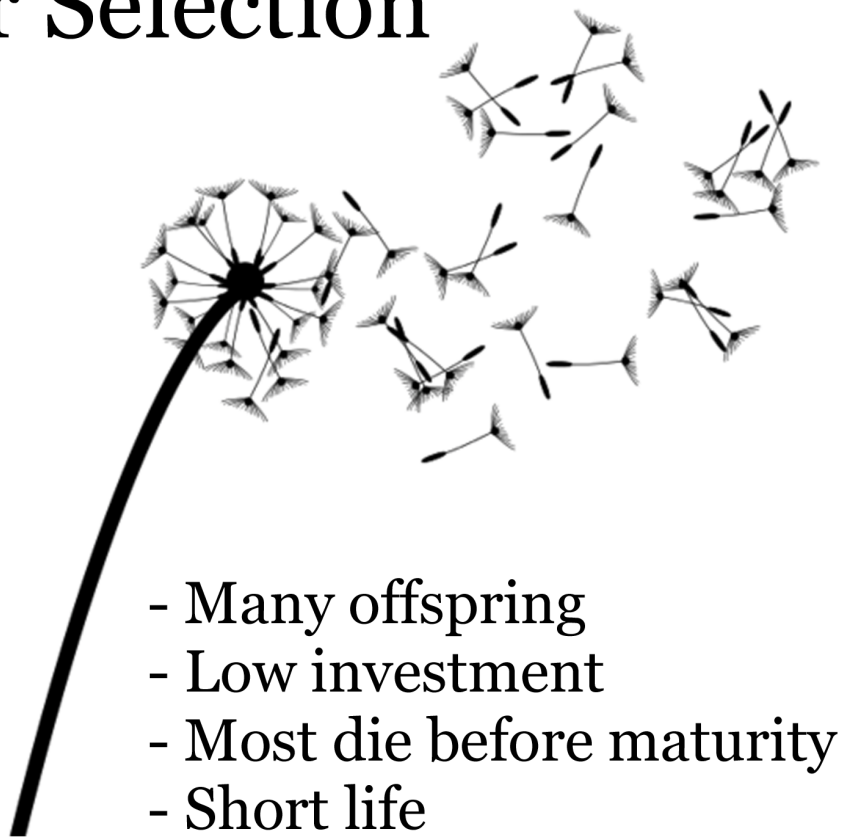
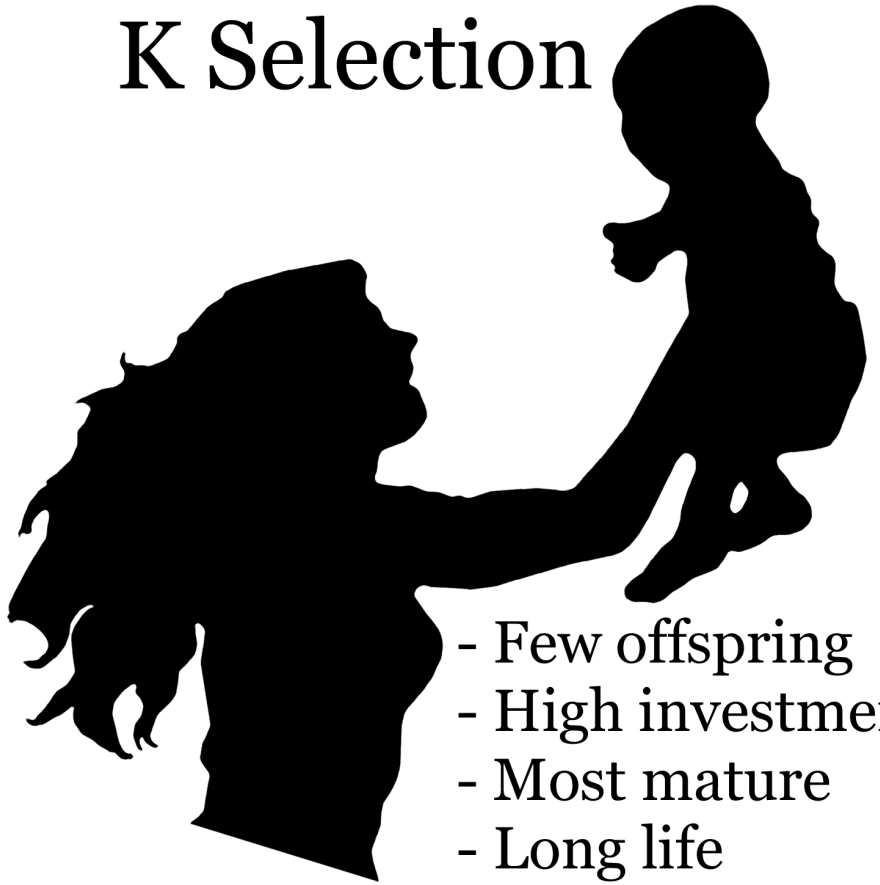


- Many offspring
- Low investment
- Most die before maturity
- Short life
- Superficial relationships
- Low individuality
- Commodities

K Selection



- Few offspring
- High investment
- Most mature
- Long life
- Rich relationships
- High individuality
- Brands

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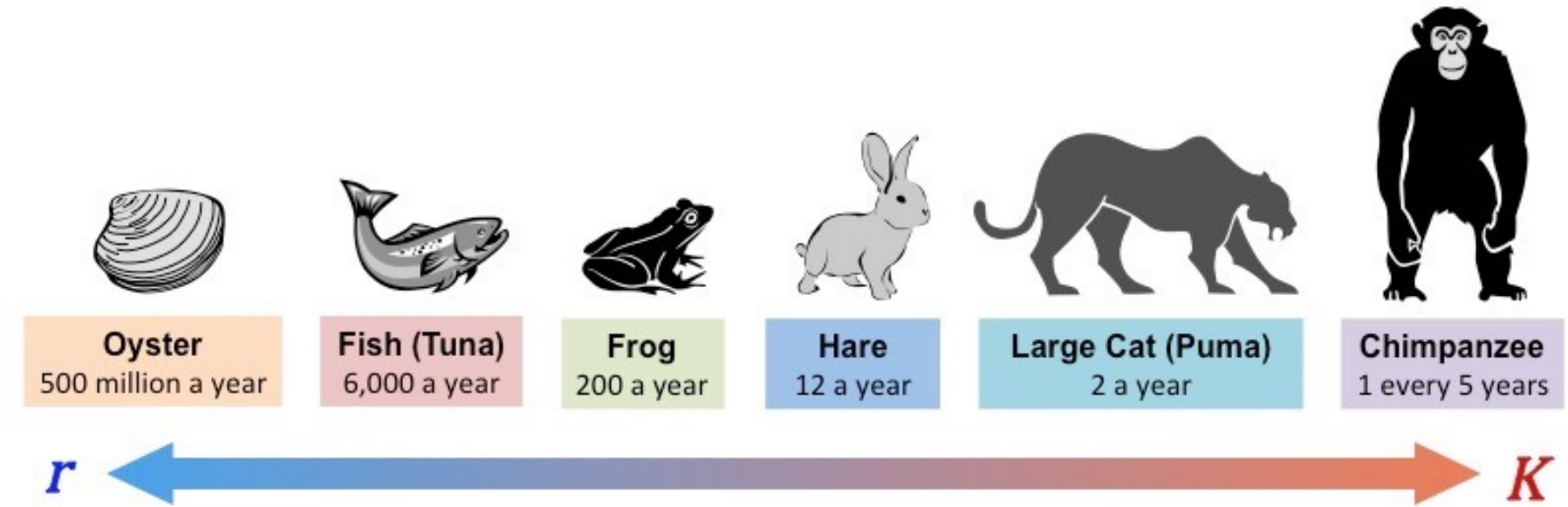

Evidence for a Quantity-Quality Trade-off [r-K Strategies]

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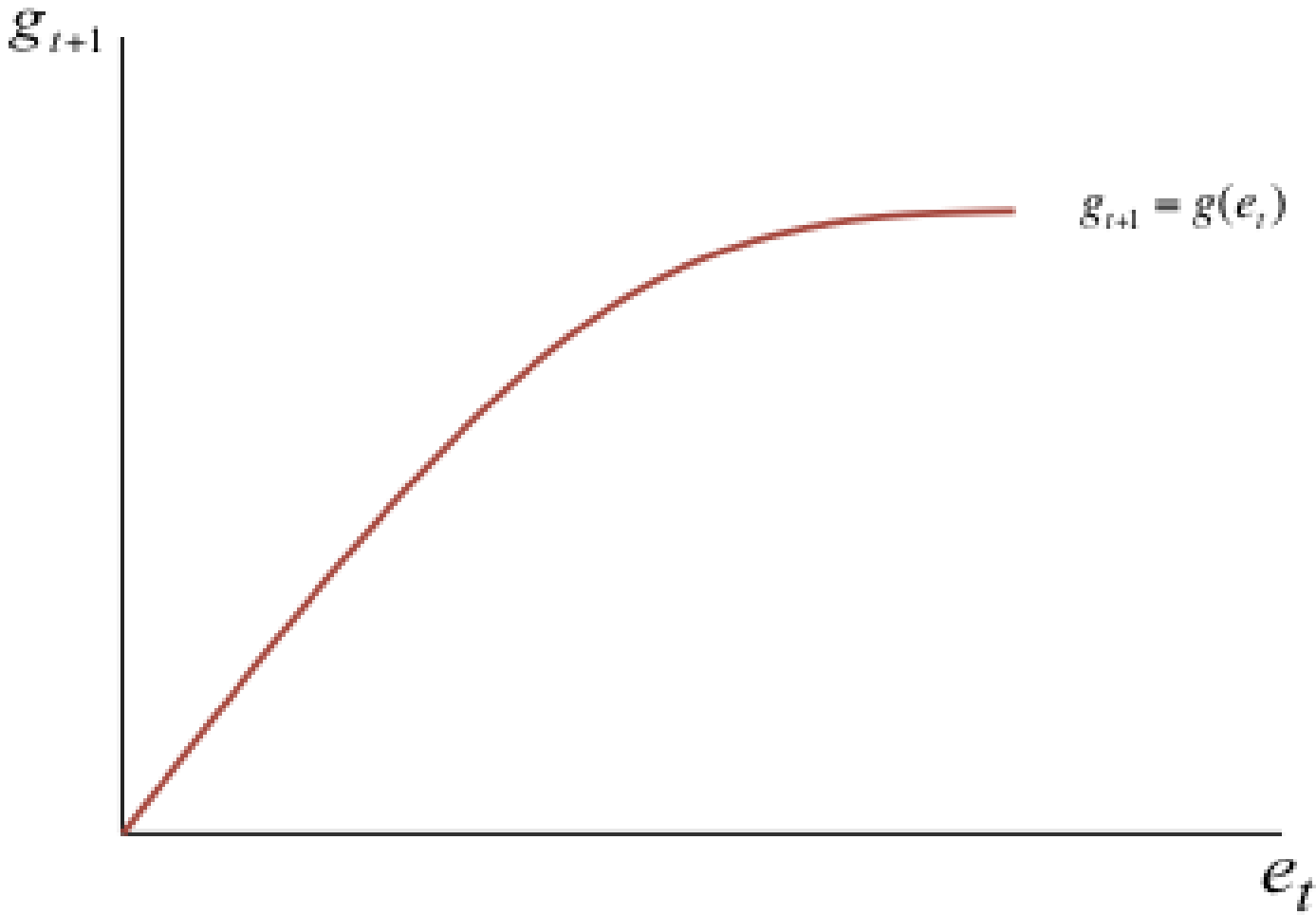
  - $g_{t+1} \equiv$ rate of tech progress between time t and time $t+1$

- But, the scale of the population has no impact on technological progress
  - Modeling assumption: Design to illustrate the role of natural selection even in the absence of scale effect

Technological Progress



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Preferences

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- Intergenerational transmission of predisposition towards quality

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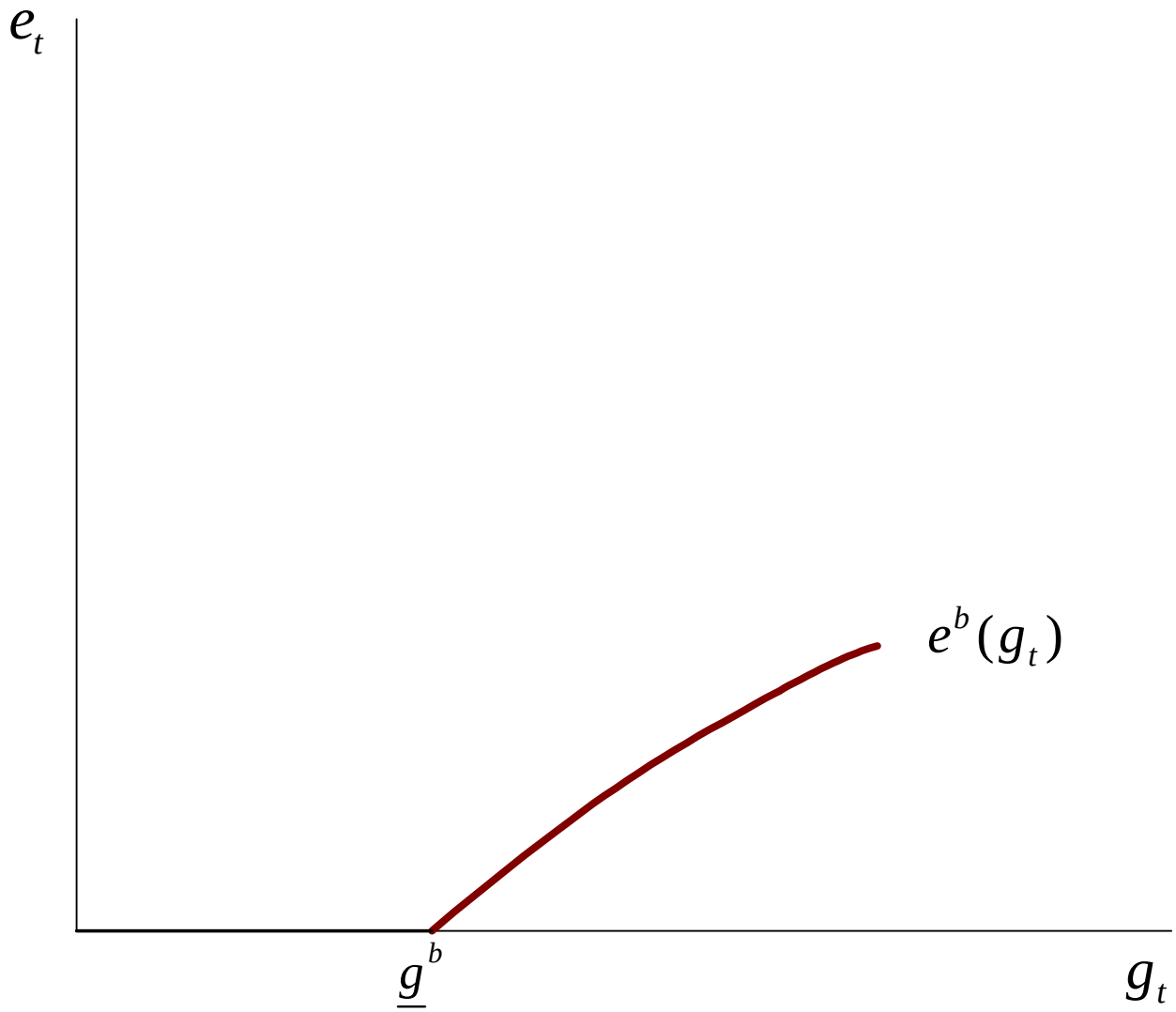
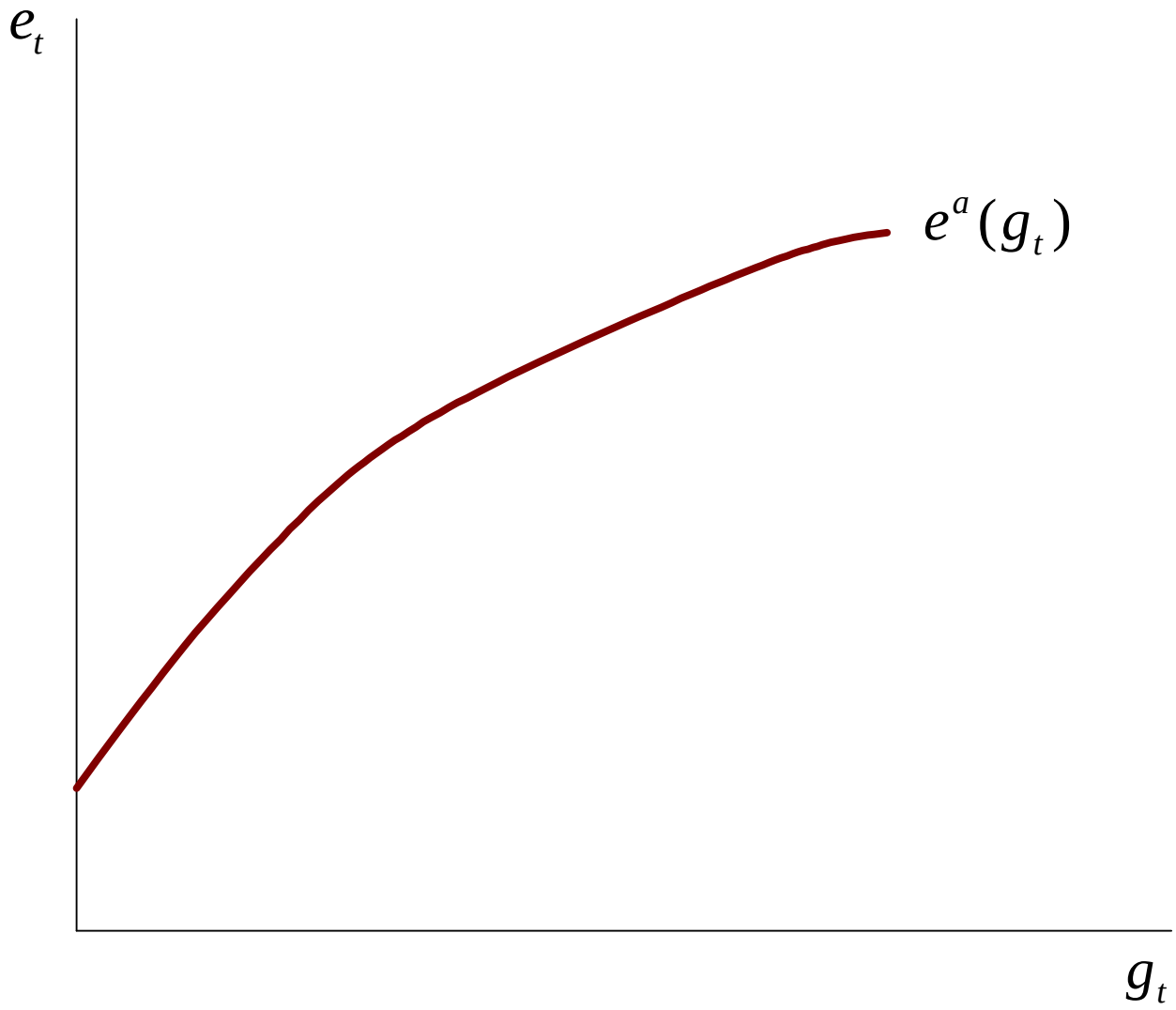
    - Yet, the existence of variety of types enables nature to select those who are most adaptable to the economic environment

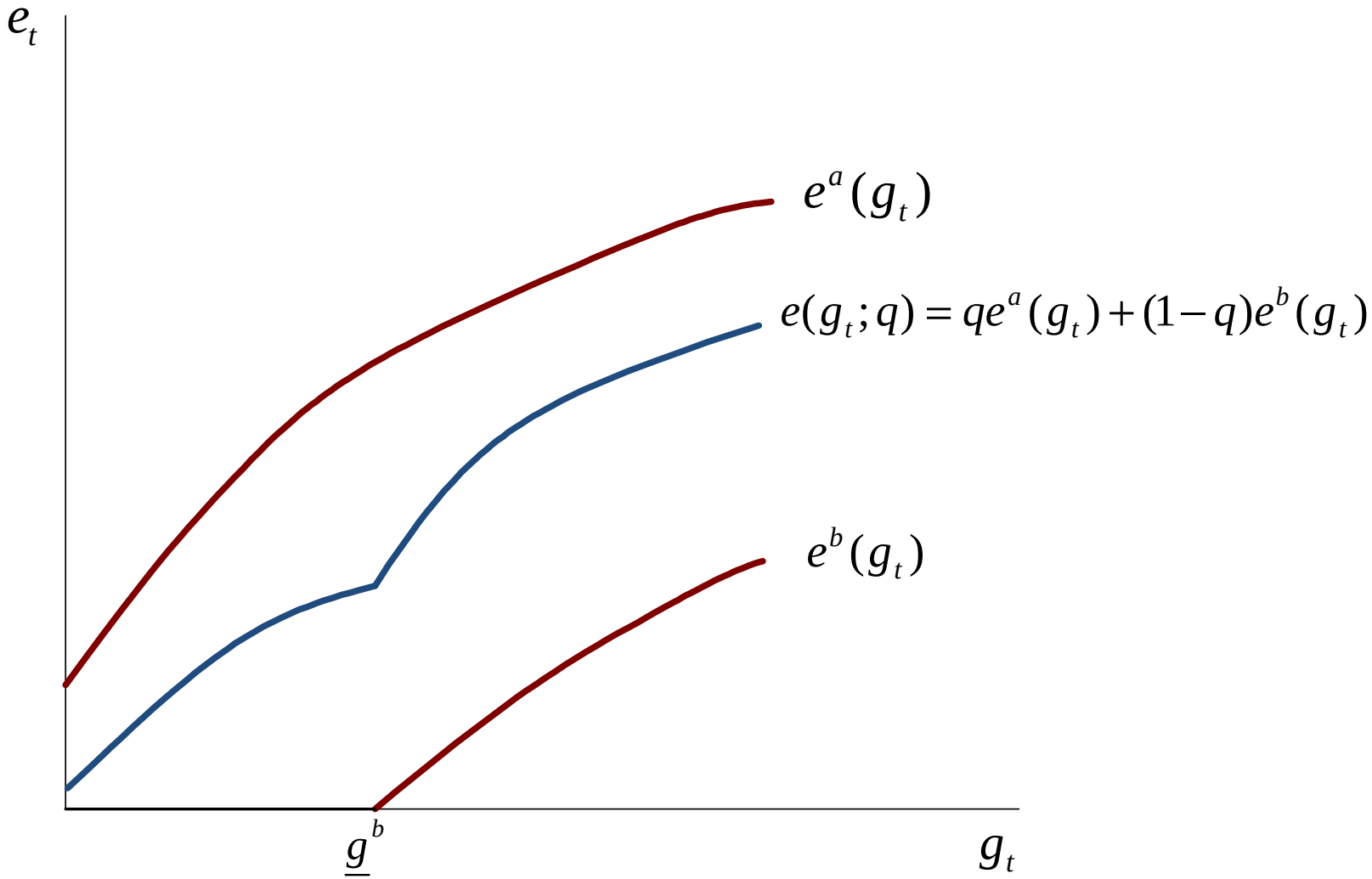
Investment in Child Quality of the "Quantity Type" (type b)



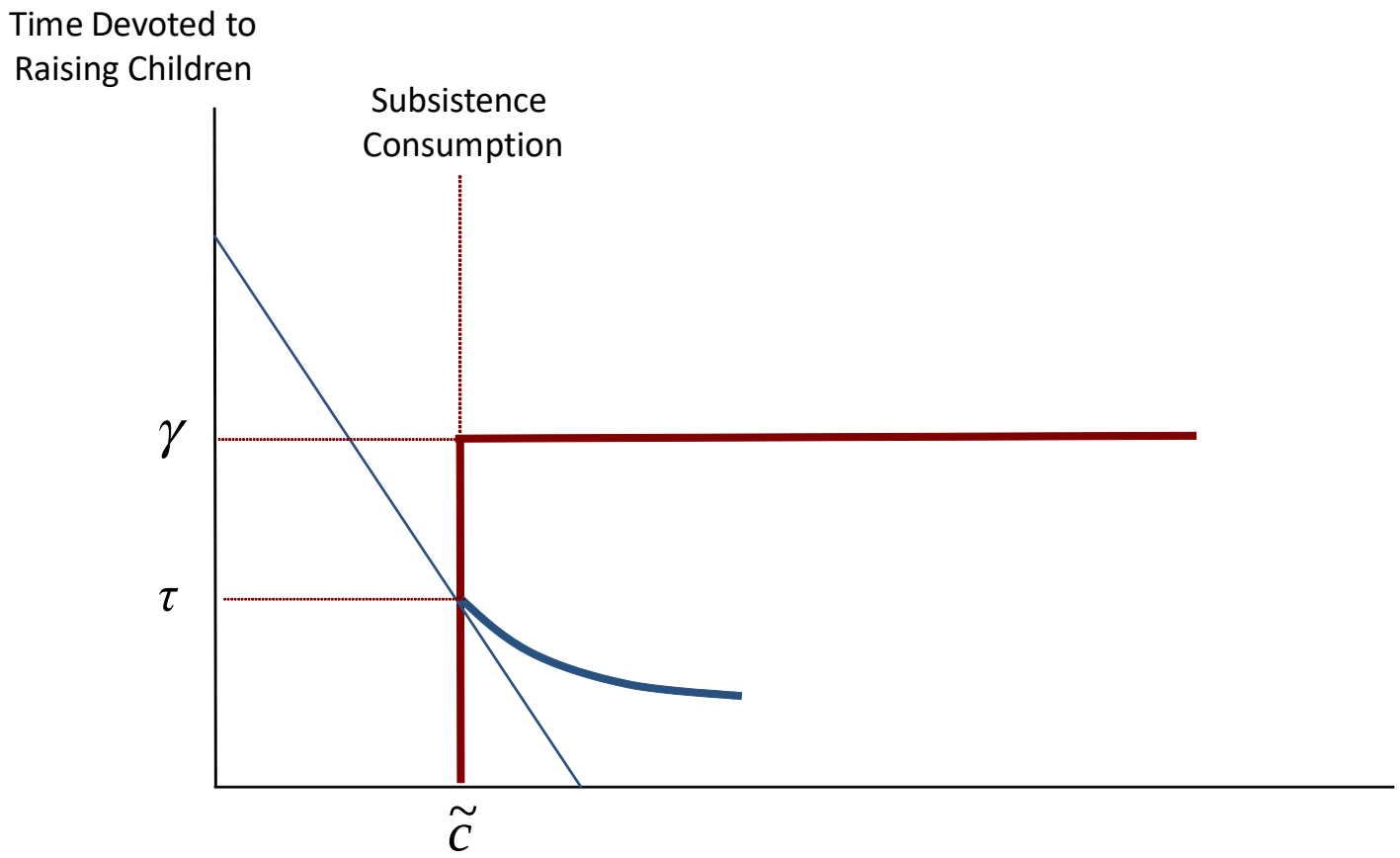
Investment in Child Quality of the "Quality Type" (type a)



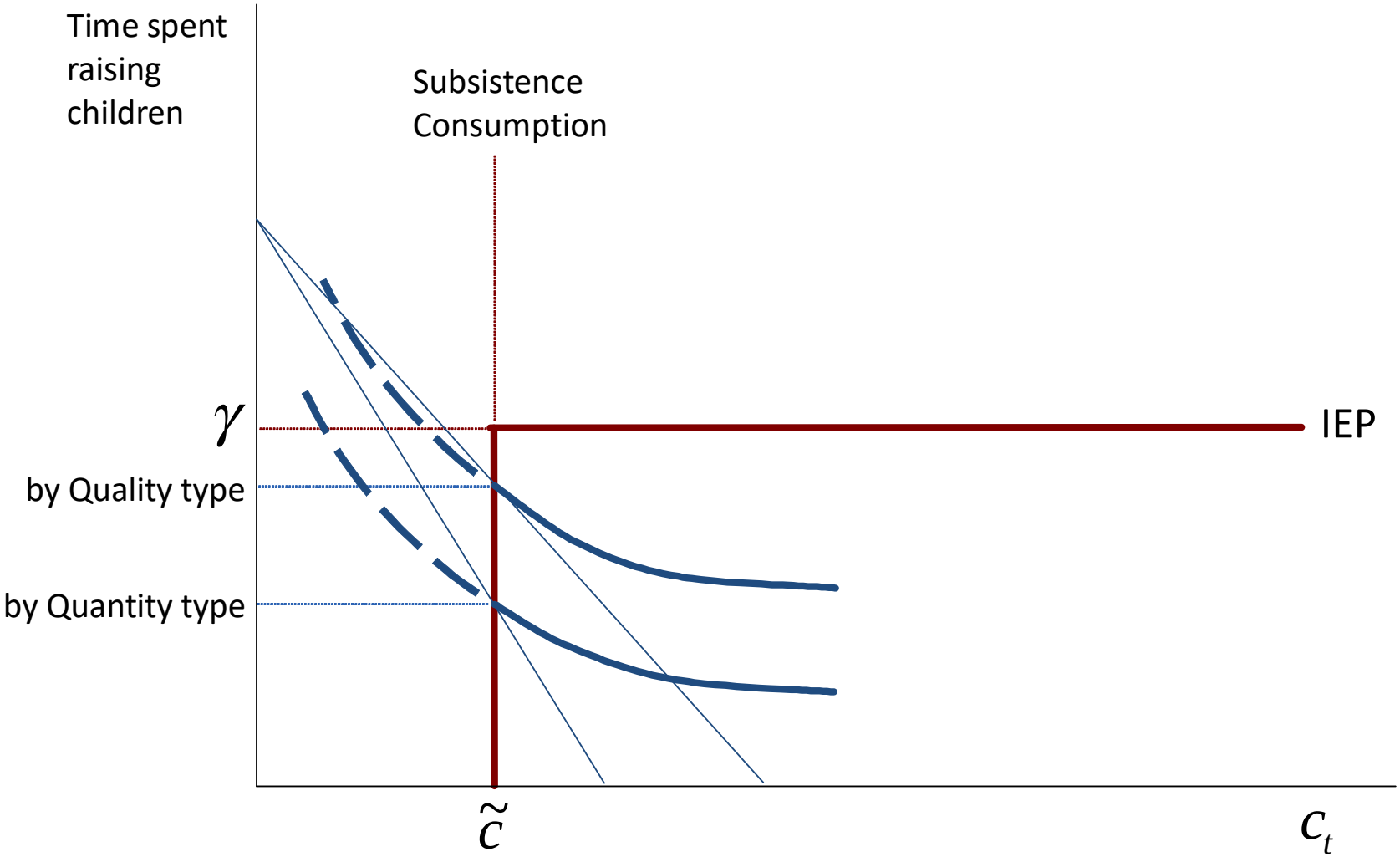
Aggregate Investment in Child Quality (weighted by the fraction q of the quality type)



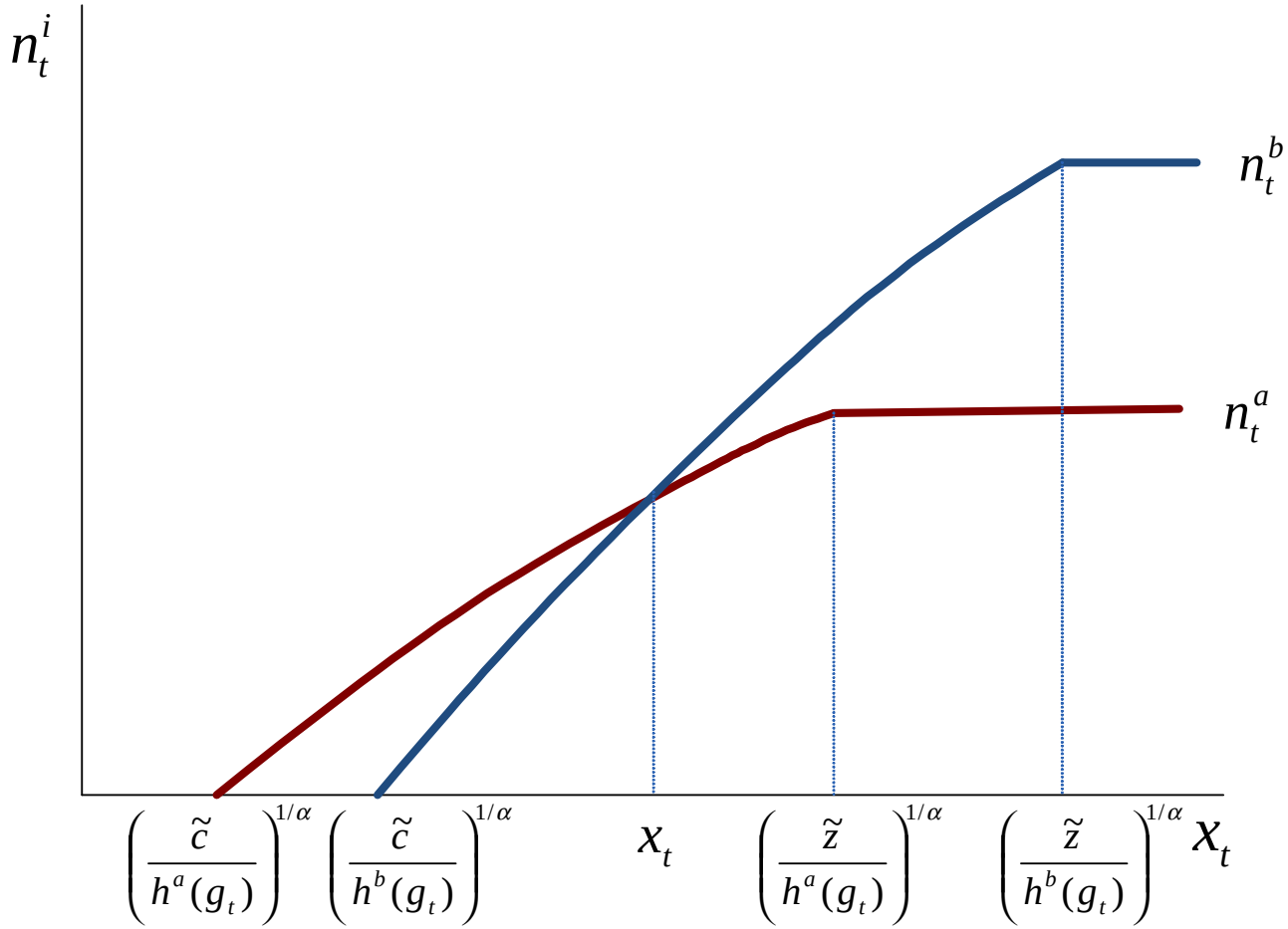
Optimization – Malthusian Epoch



Evolutionary Advantage of the Quality Type



Evolutionary advantage of the "Quality Type" (till the demographic transition)



The Dynamical System

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

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

- $q_t \equiv$ the fraction of the quality type in the population at time t

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Conditional Evolution of Technology and Education

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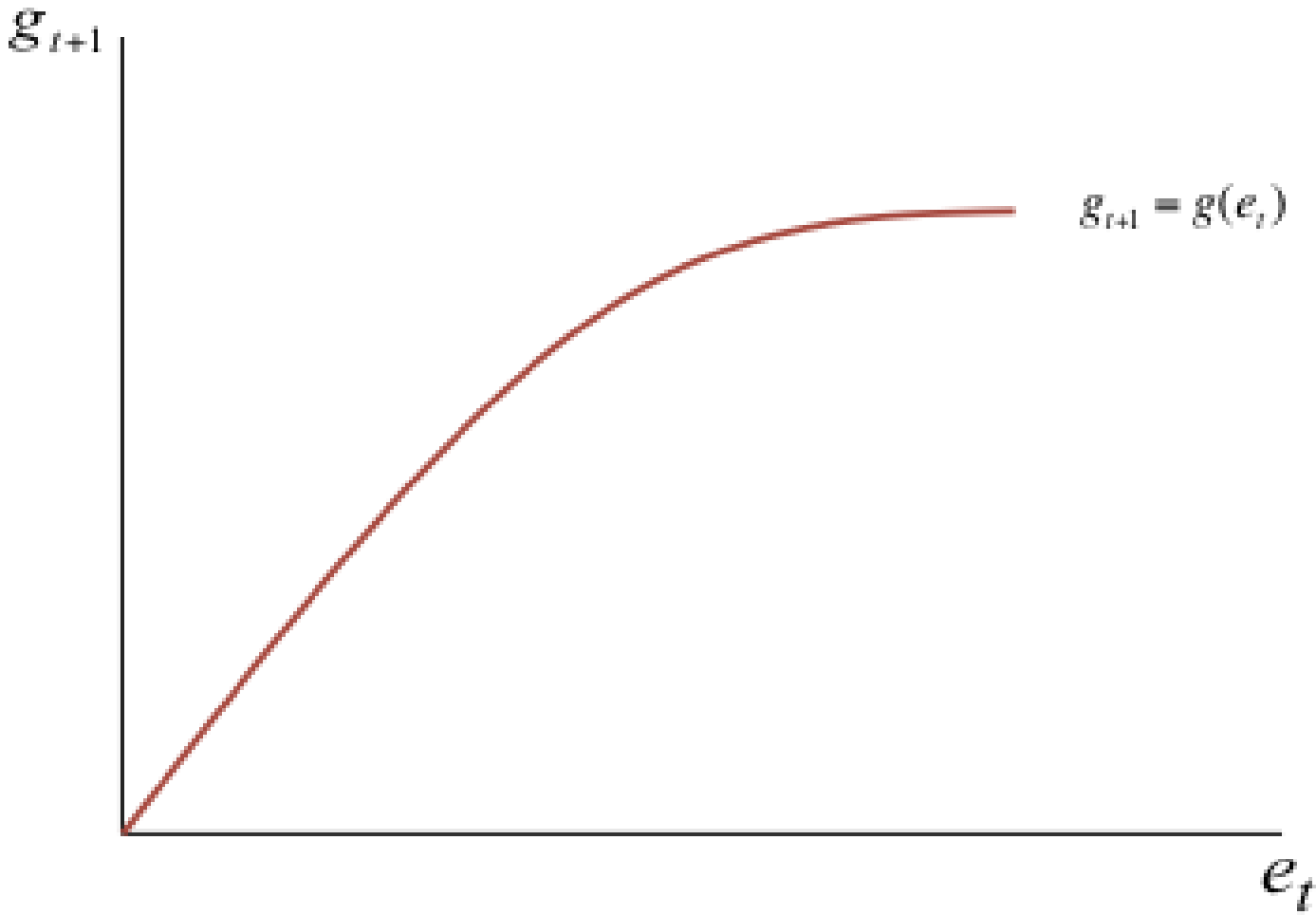
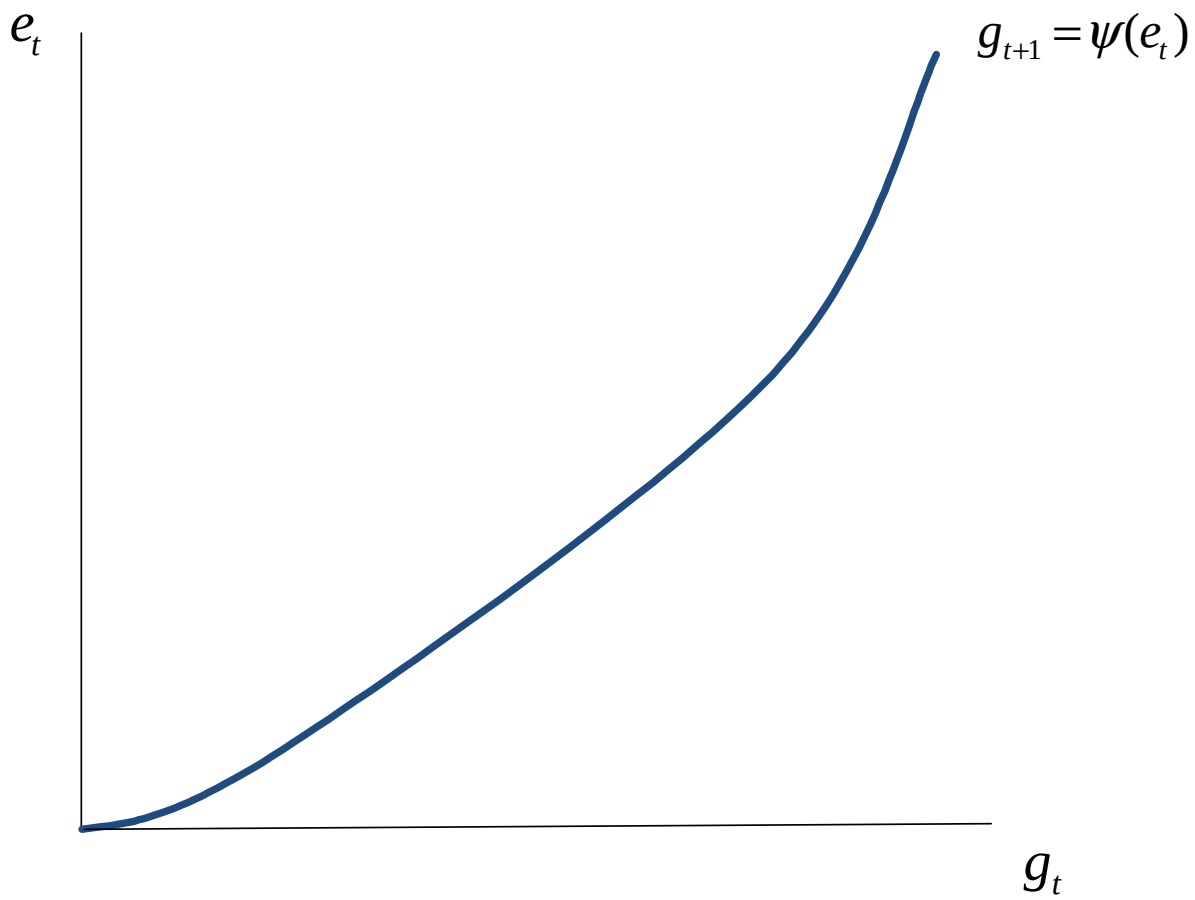
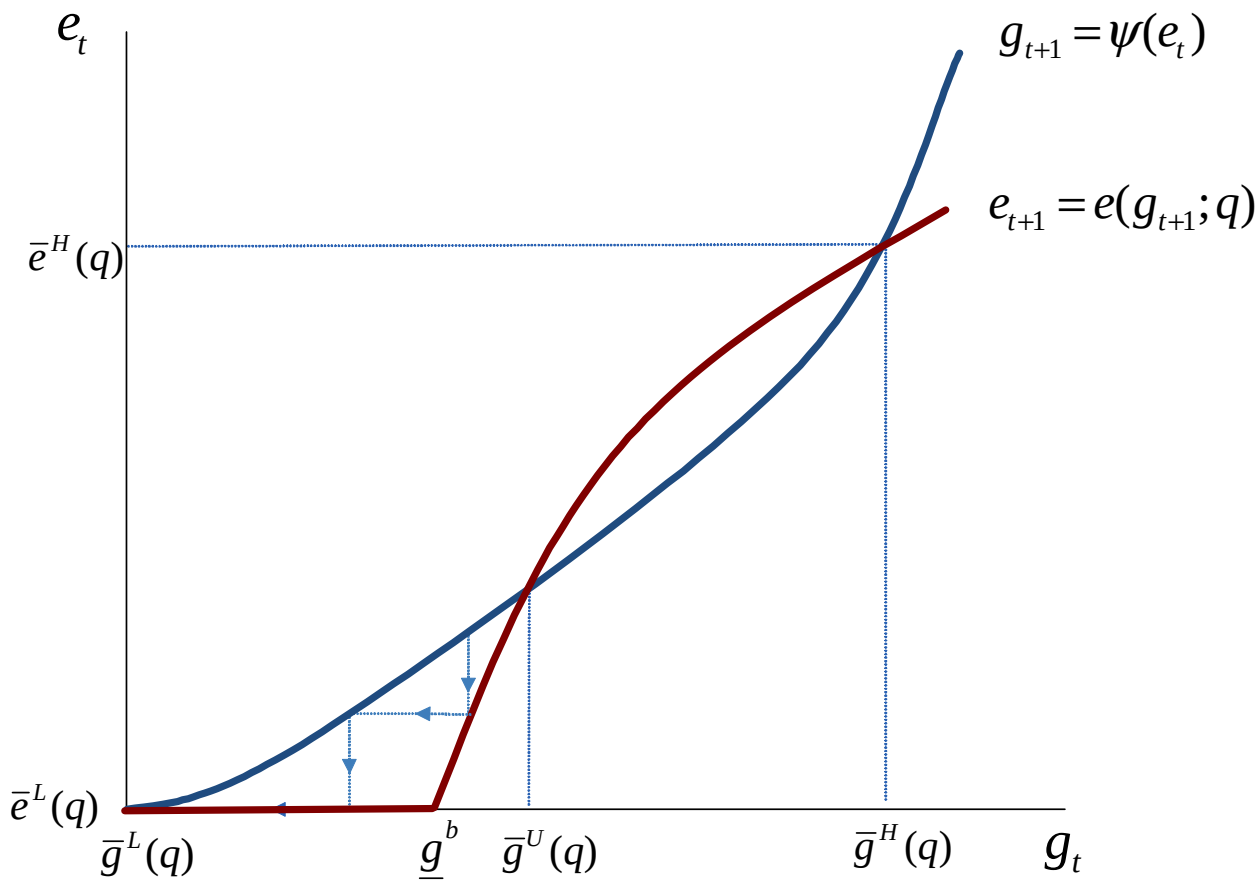
Technological Progress



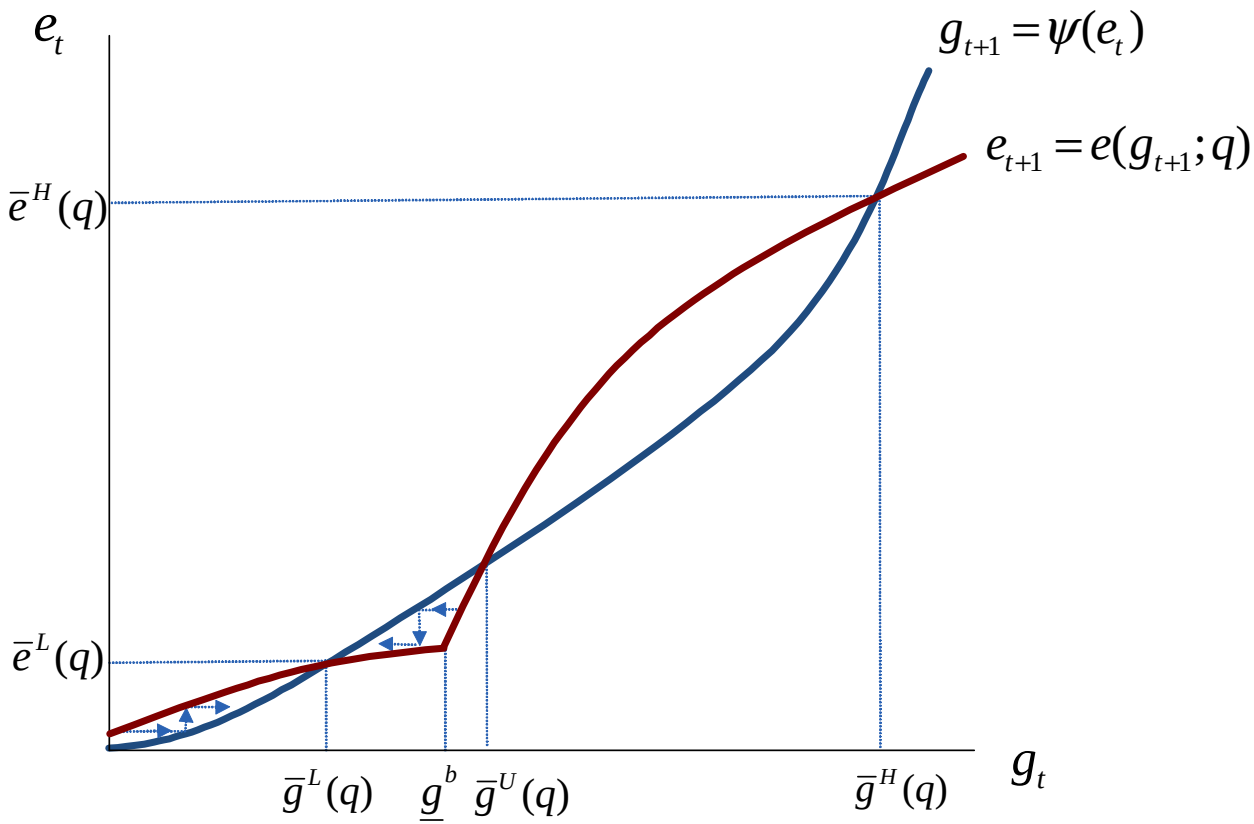
Technological Progress - Flipped Axis



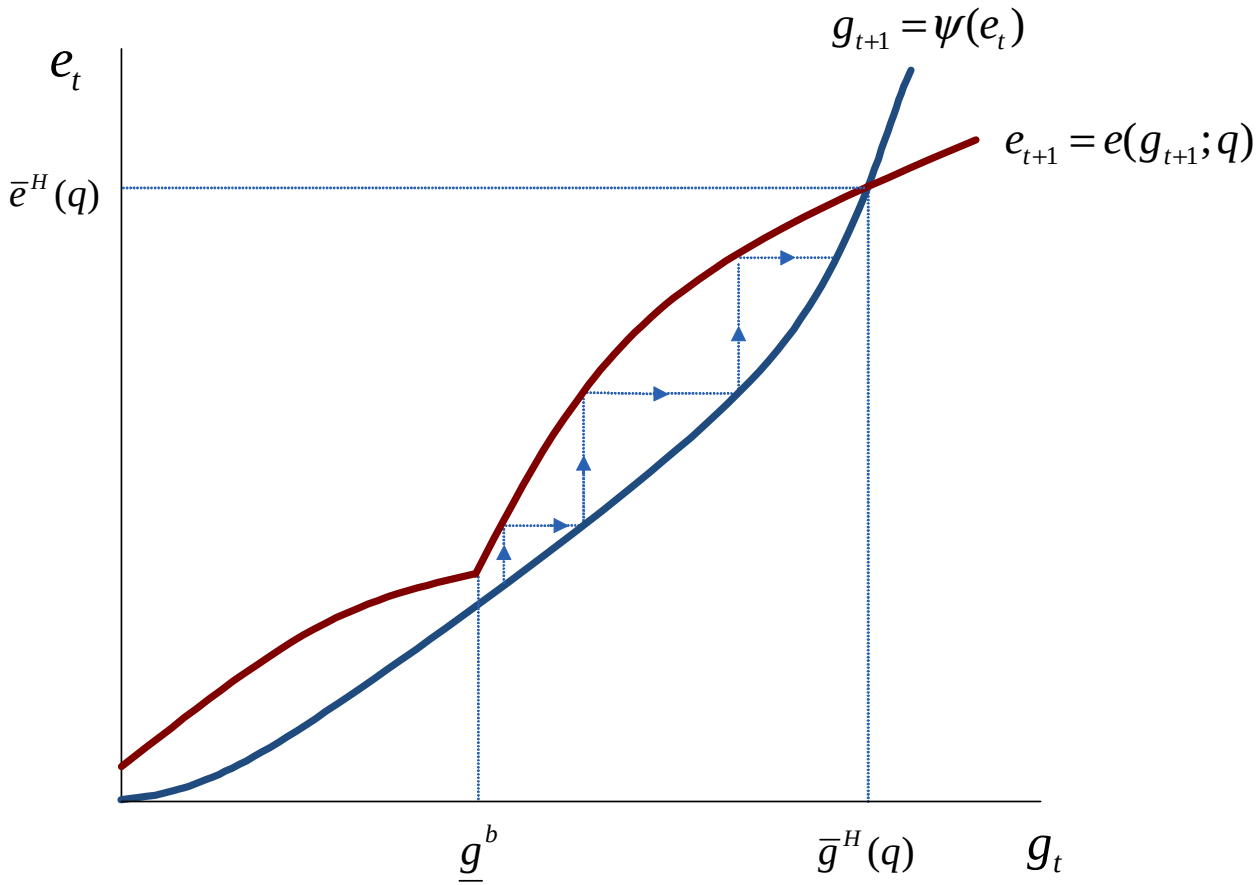
Evolution of Education & Technology: Malthusian Equilibrium
The fraction of the "Quality Type" $q \sim 0$



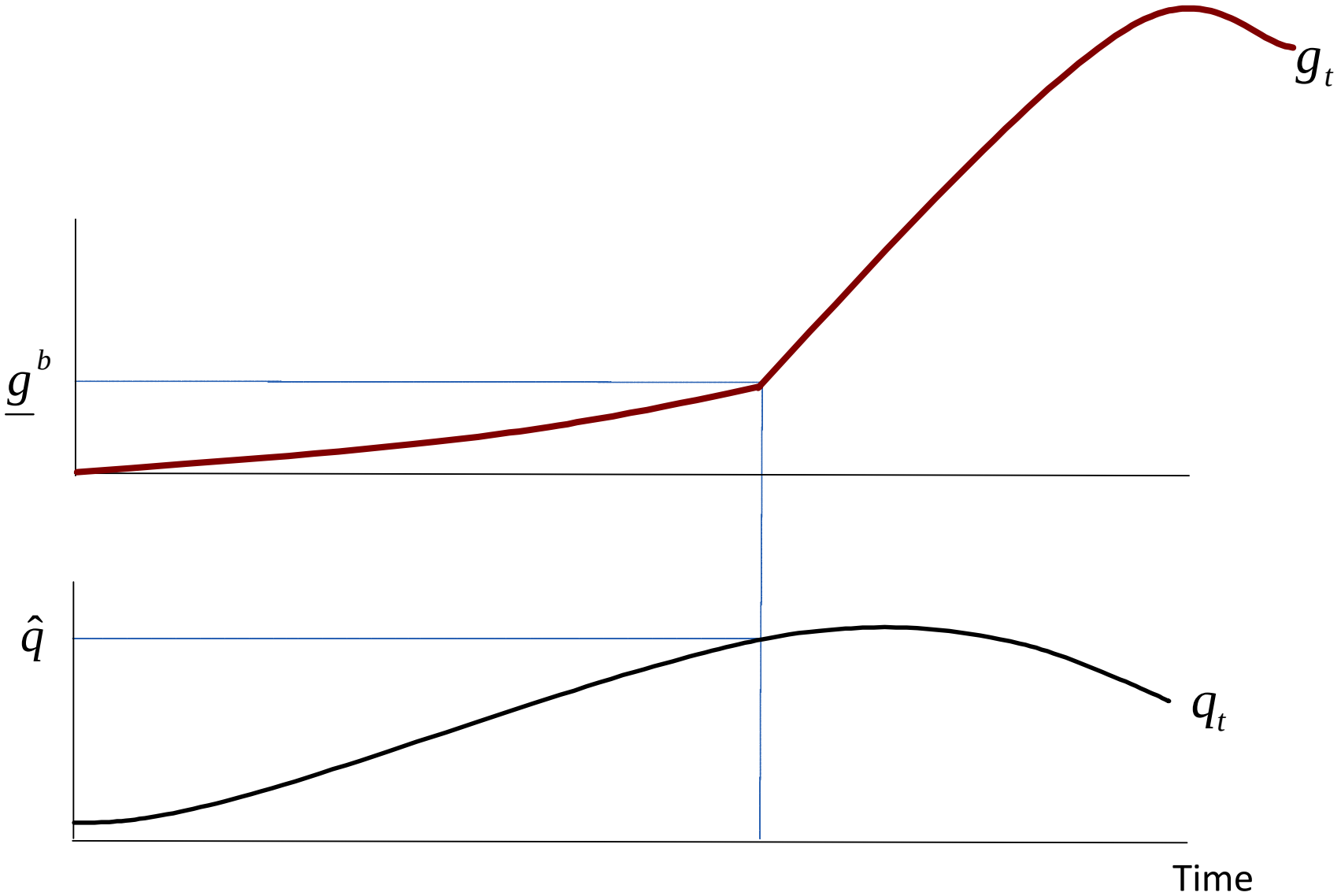
Evolution of Education & Technology: Malthusian Equilibrium
Fraction of the "Quality Type" Increases due to Natural Selection – q > 0



Evolution of Education &Technology: Take-off
Fraction of the "Quality Type" Increases due to Natural Selection beyond $\hat{q}$



The Evolution of the fraction of the Quality Type (q) & TFP Growth (g)



Evolutionary Growth Theory

- In the pre-demographic transition era

Evolutionary Growth Theory

- In the pre-demographic transition era
  - Natural selection

Evolutionary Growth Theory

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  - Natural selection
    - Increased the prevalence of predisposition towards child quality

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Evolutionary Growth Theory

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    - Increased the prevalence of predisposition towards child quality
    - Fostering technological progress
    - Expediting the demographic transition
    - Excelarating the transition from stagnation to growth
  - In the post-demographic transition era:
    - Predisposition towards child quality declined
    - Yet the process is irreversible and economic growth is sustained