

How Does Research Effect Economic Growth?

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Humboldt Institution on Transatlantic Issues

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*Potenzialausschöpfung im Forschungssystem
ein Vergleich zwischen Deutschland und den USA*

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Economic Growth

Neoclassical
Growth Model

Human Capital

Research and
Development

Discussion/
Summary

- Economic Growth:
Concepts, Stylized Facts and Theories
- Technological Progress
within the Neoclassical Growth Model
- Human Capital
 - Learning-By-Doing
 - Learning-By-Schooling
- Research and Development
- Discussion/Summary

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Neoclassical
Growth Model

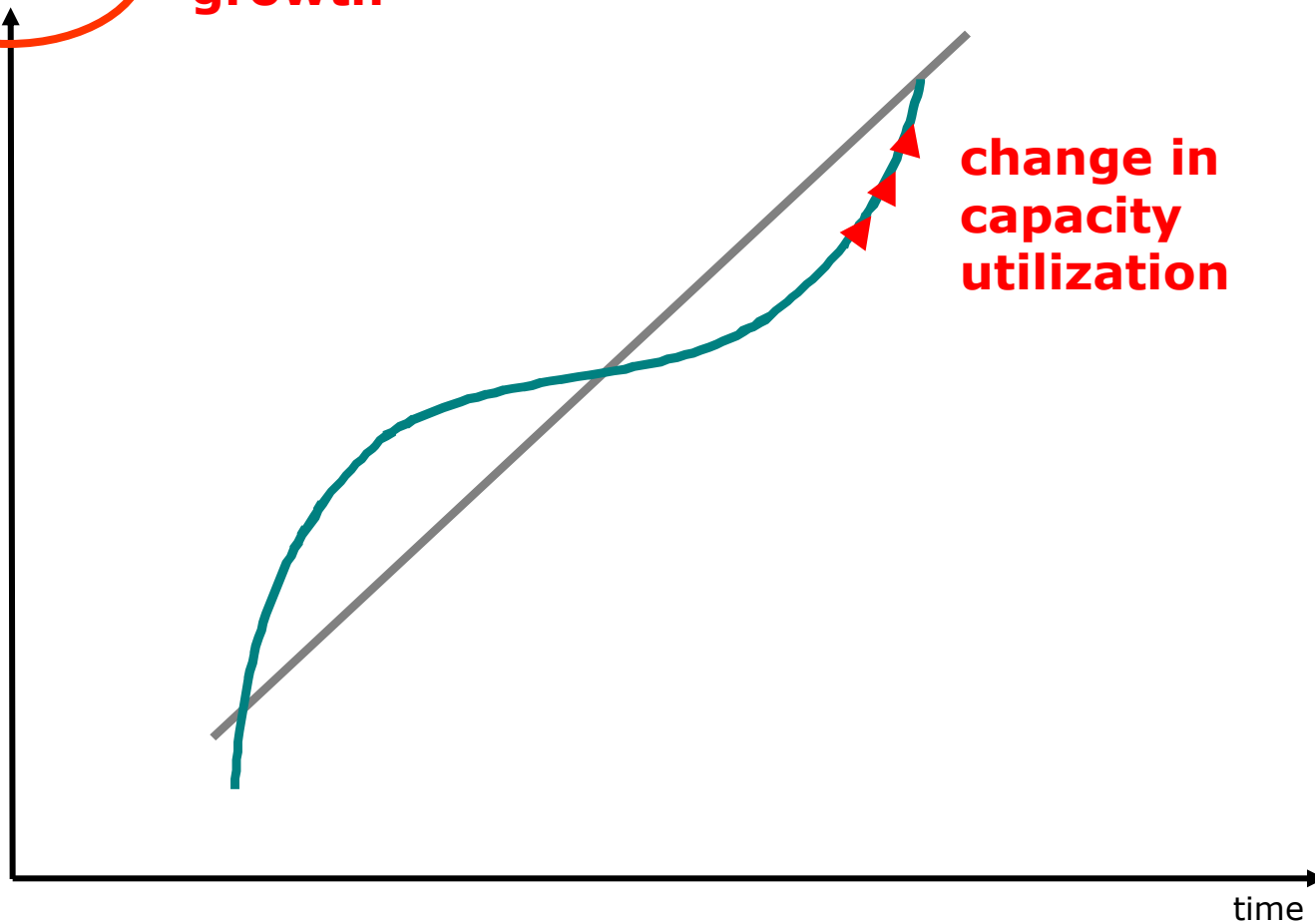
Human Capital

Research and
Development

Discussion/
Summary

per capita
production

**intensive
growth** ⇒ **increasing (labor) productivity**



**change in
capacity
utilization**

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Increase in Productive Capacity

Economic Growth

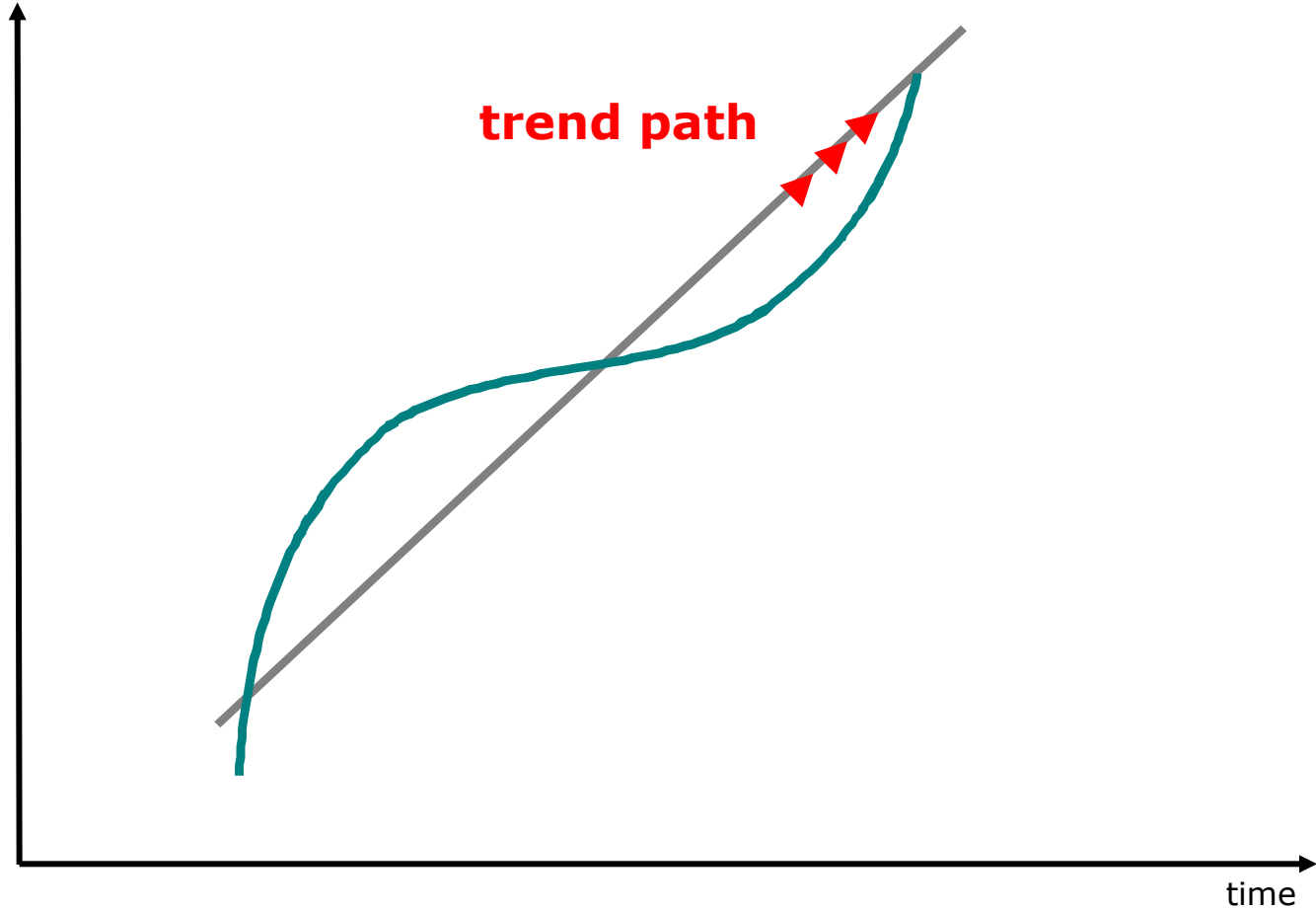
Neoclassical
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per capita
production



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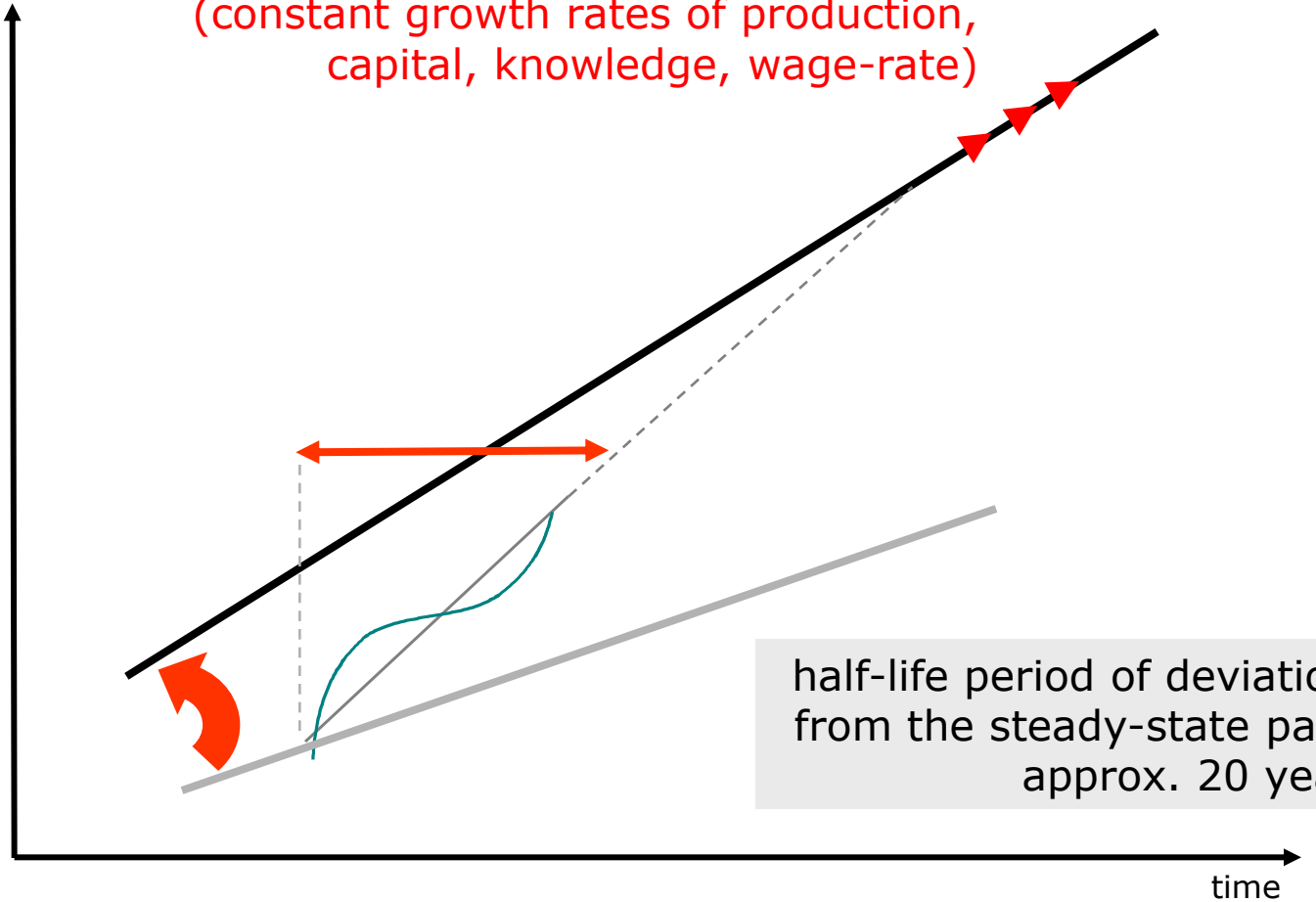
Human Capital

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per capita
production

steady-state
(constant growth rates of production,
capital, knowledge, wage-rate)



half-life period of deviations
from the steady-state path:
approx. 20 years

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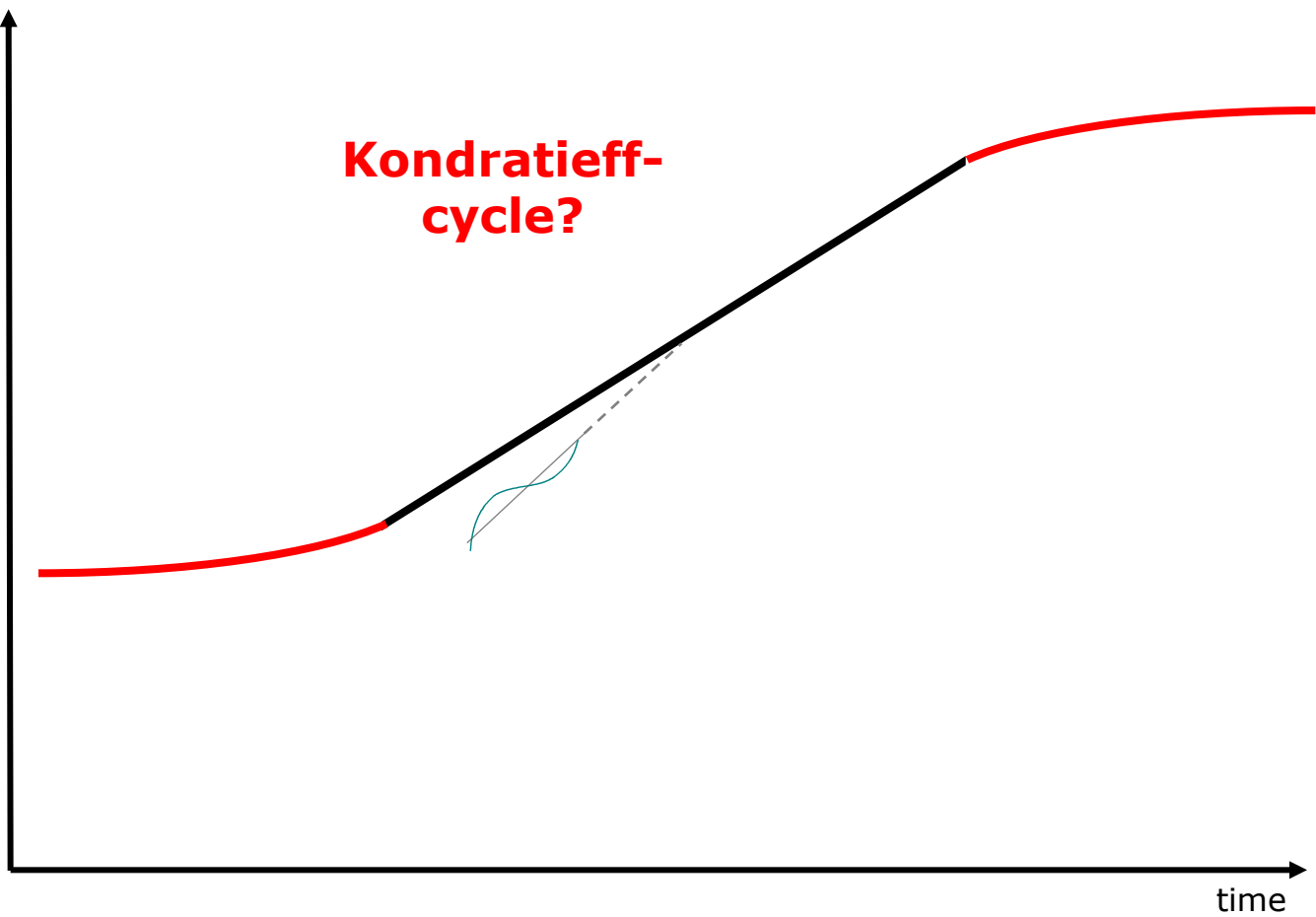
Human Capital

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per capita
production

**Kondratieff-
cycle?**



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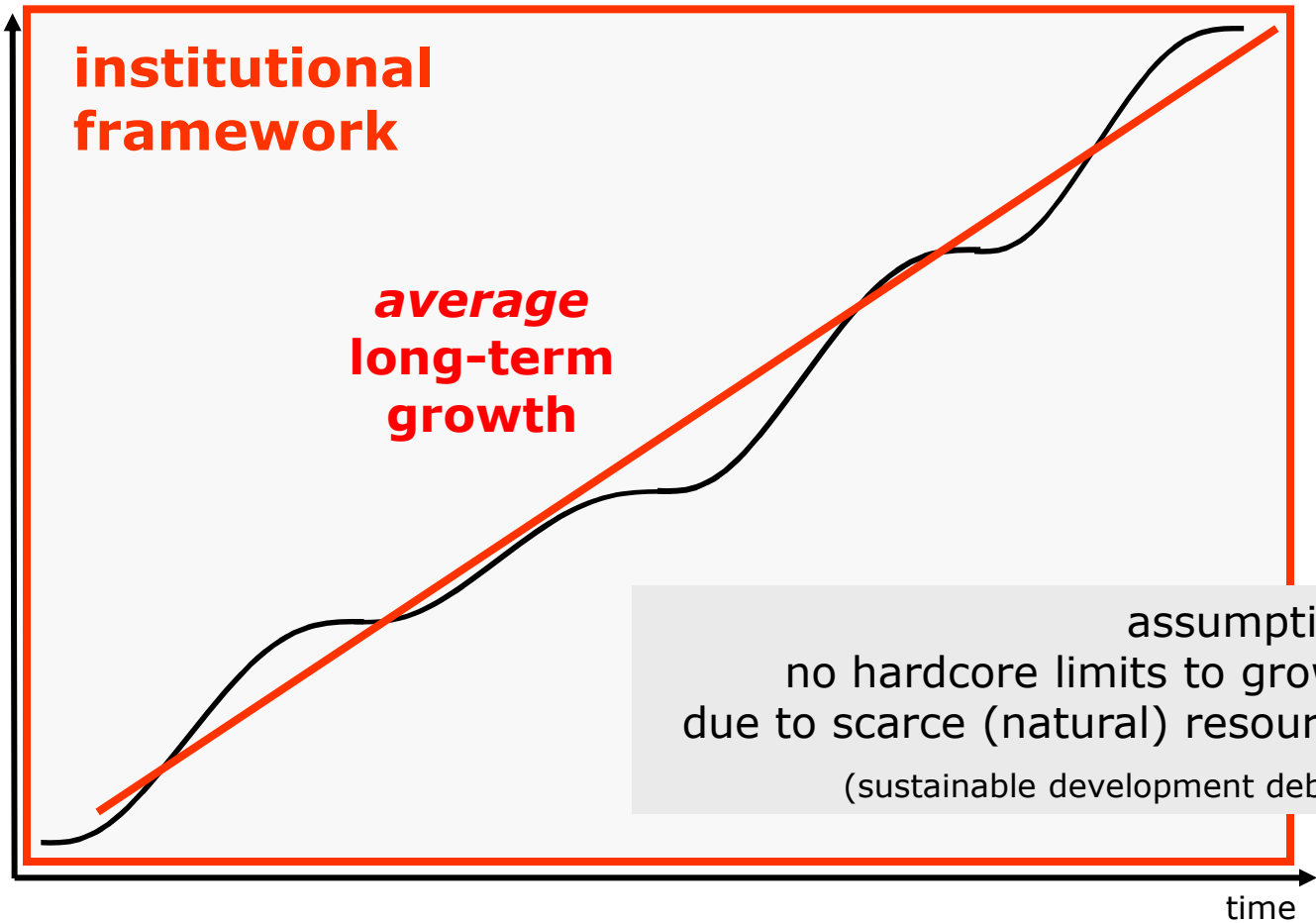
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Summary

- industrialized countries
 - persistent increase in labor productivity (\emptyset : 2% p. a.)
 - constant capital-output ratio
- no general convergence, but (regional) clusters
- growth engine:
R&D combined with imperfect competition (but: no clear correlation between R&D expenditures and growth rate)
- learning curve:
more important to developing countries than to industrialized countries
- microeconomic view: innovation more important a competition advantage of firms than prices/quantities

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- **Classics** \Rightarrow secular stagnation thesis
(Smith, Ricardo, Malthus, Marx)
- **Evolutionary Economics** \Rightarrow “Creative Destruction”
(Schumpeter)
- **Postkeynesians** \Rightarrow instability problems
(Harrod, Domar, Kaldor, Robinson)
- **Neoclassics** \Rightarrow exogenous technological progress
(Solow, Arrow, Uzawa, Shell)
- **New Growth Theory** \Rightarrow endogenous techn. progress
(Barro, Grossman, Helpman, Lucas, Romer, Sala-i-Martin)
- **Semi-endogenous Growth Theory** \Rightarrow endog. techn.
progress and human capital accumulation
(Jones, Arnold)

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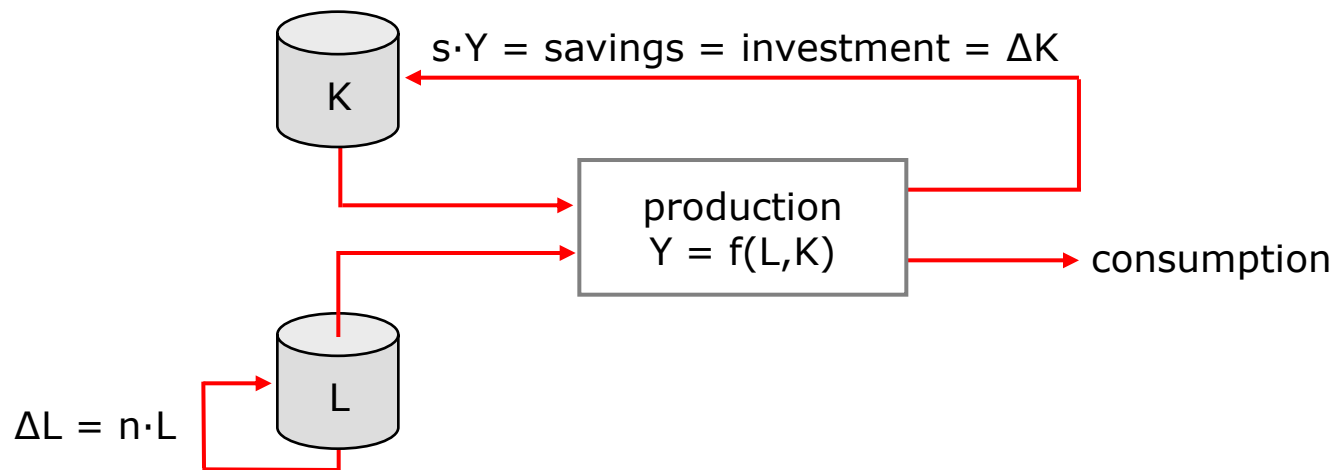
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**Neoclassical
Growth Model**

Human Capital

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Development

Discussion/
Summary



- exogenous population (labor) growth rate n
- saving rate: exogenous or derived via dynamic (= intertemporal) optimization (rate of time preference)

$$g_Y = n \quad \text{and} \quad g_y = 0$$

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Barriers to Capital Accumulation / Effect of Technological Progress

Economic Growth

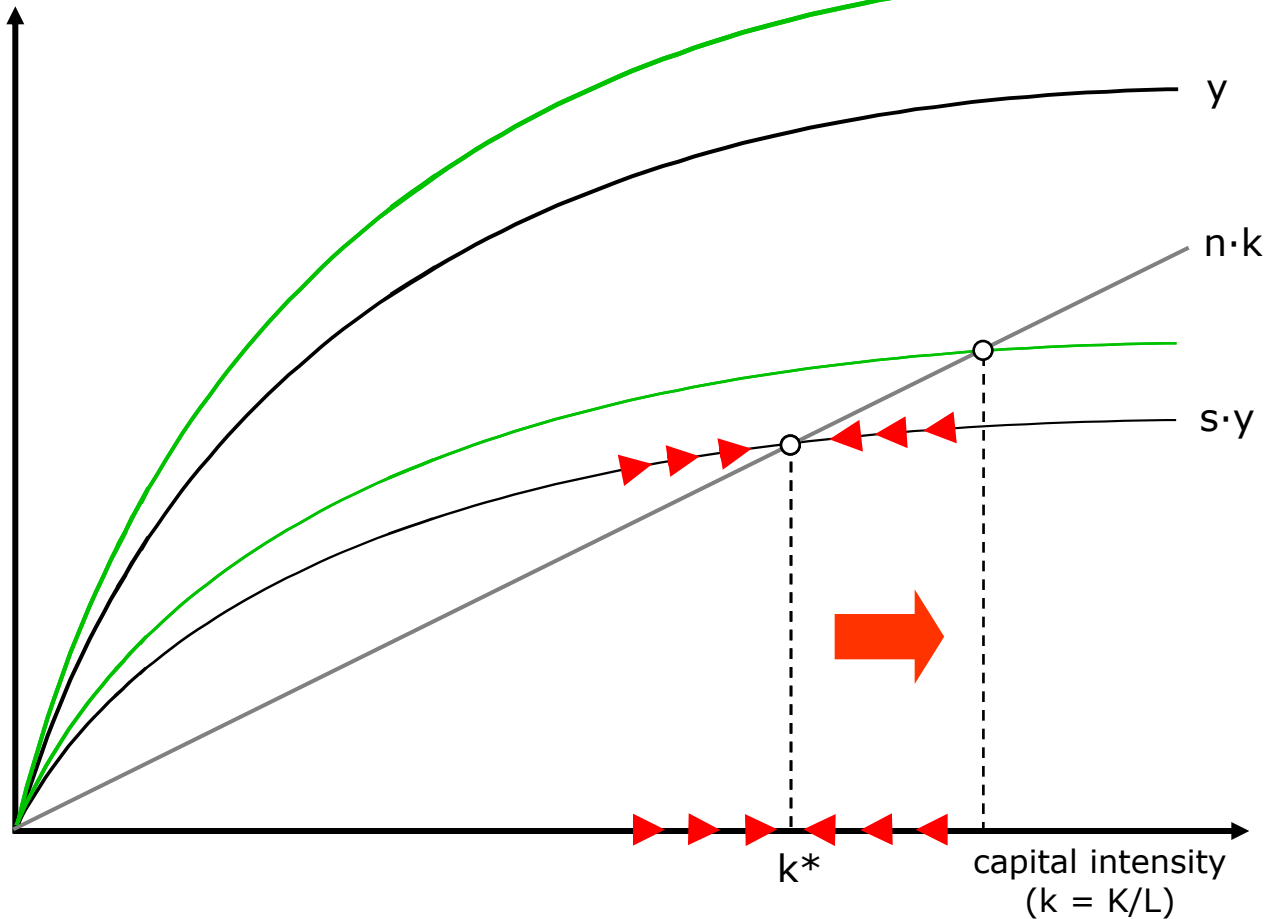
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per capita
production



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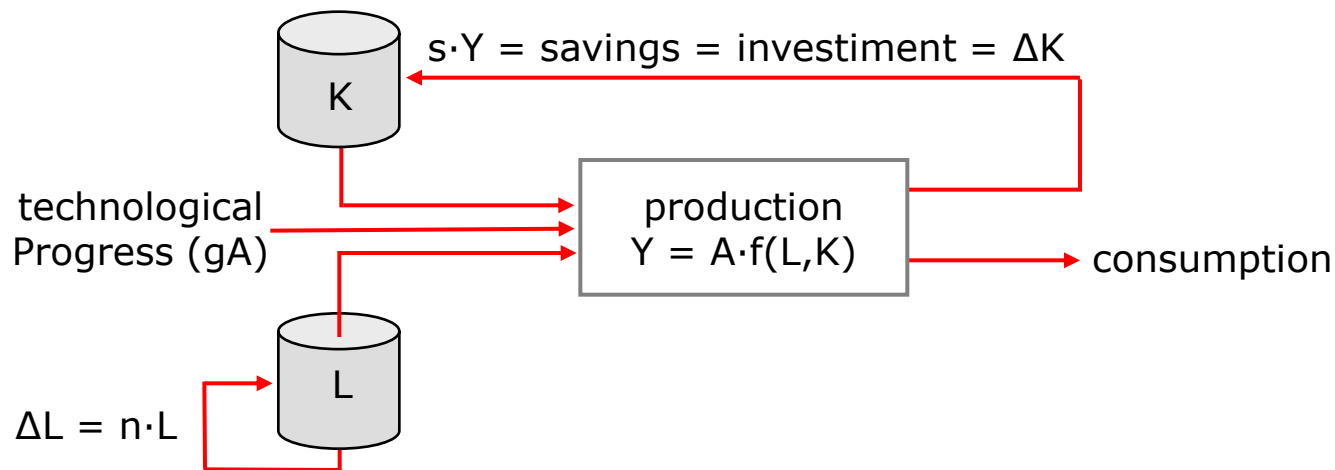
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- exogenous, disembodied, factor augmenting technological progress (alternative: vintage-models)
- technological progress does not consume any resources but is “produced by time” (like manna from heaven)

$$gY = n + gA \quad \text{and} \quad gy = gA$$

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Economic Growth

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Summary

- reason for endogenous long-term stagnation: diminishing returns of the reproducible factor (capital stock)
- steady-state growth rate independent from savings/investment
- per capita growth rate = technological progress growth rate
- worldwide diffusion of knowledge guarantees perfect global convergence of steady state growth rates
- conditional convergence
 - poor countries catch up (higher transitional growth)
 - per capita income depends on saving rate (+), population growth rate (-) and technological progress (+)

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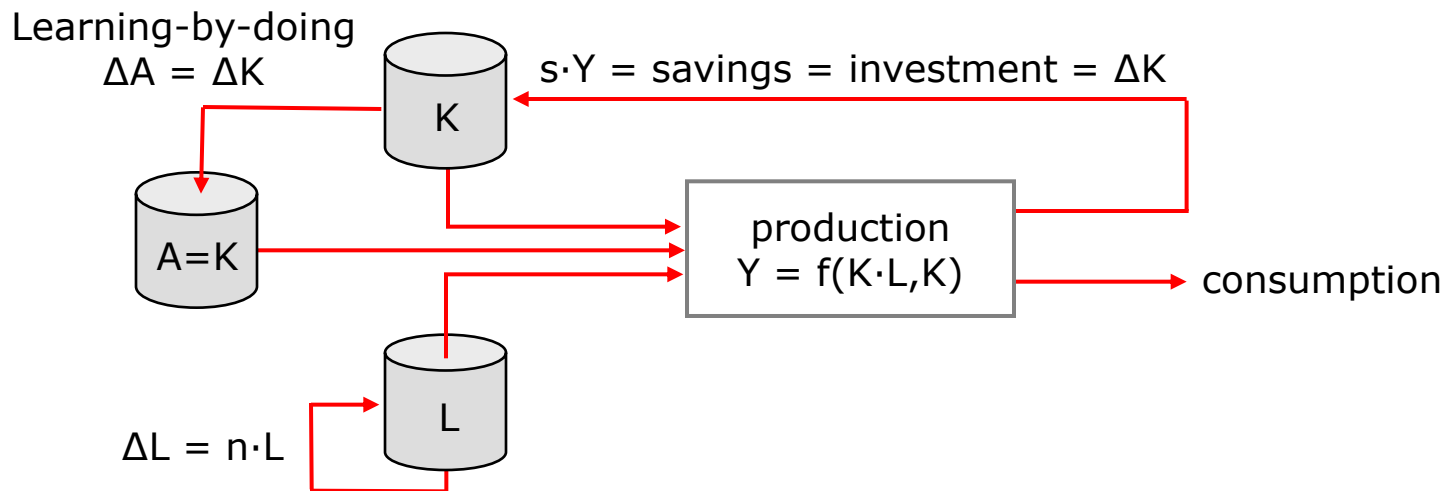
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Summary



- labor augmenting technological progress with capital stock as a proxy for accumulated experience (know-how)
- growth engine: production becomes proportional to capital stock (no more diminishing returns to scale!)
- steady-state growth rate influenced by: saving rate (rate of time preference), country size, technology
- know-how as a public good (externality)
 - ⇒ inefficient steady-state growth rate
 - ⇒ suggests public subsidies for investments

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Human Capital Accumulation (Learning-by-Schooling/Learning-or-Doing)

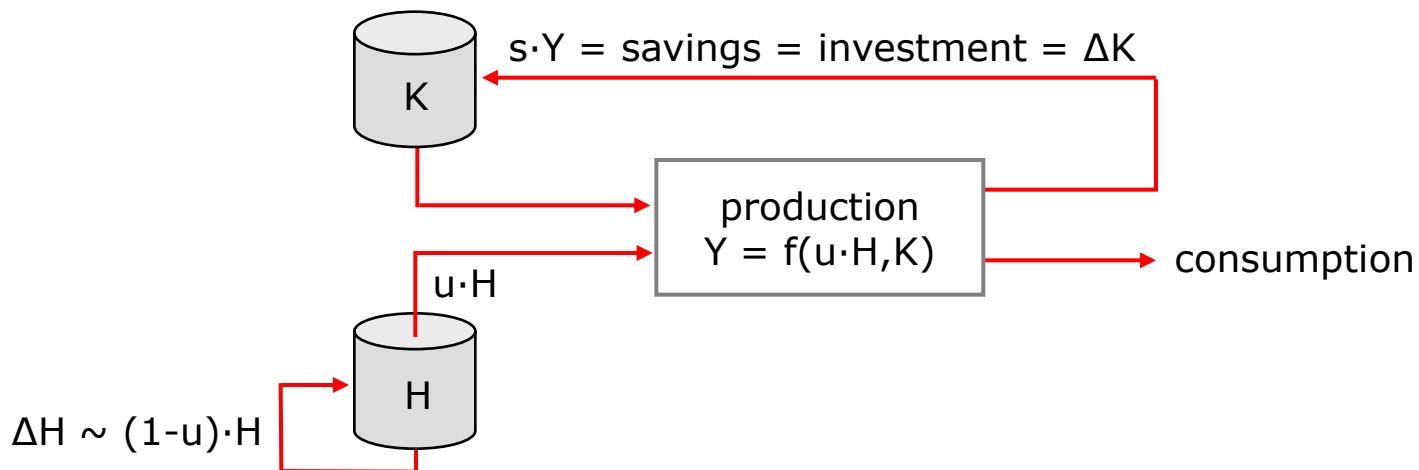
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- labor-embodied know-how (infinite time horizon or depreciation)
- growth engine: no diminishing returns to scale in human capital formation ($\Delta H \sim H$)
- steady-state growth rate influenced by: saving rate, productivity of the education sector
- efficient steady-state growth rate (optimal allocation of resources via market processes)

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Producing Technological Progress via Research & Development

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**Research and
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Discussion/
Summary

- reasearch done by rational, profit-maximizing agents
- (old) idea: growth is sustained by increased specialization of labor
- incentives to innovate (monopoly profits) stem from imperfect competition in the intermediate sector (patent protection)
- growth engine: spillovers and specialized capital
- steady-state growth rate influenced by:
 - productivity in the R&D-sector
 - stock of human capital
 - saving rate
 - productivity in the final goods sector (negative!)
- ineffizient steady-state growth rate (too low) due to spillover-externalities

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Producing Technological Progress via Research & Development (Cont.)

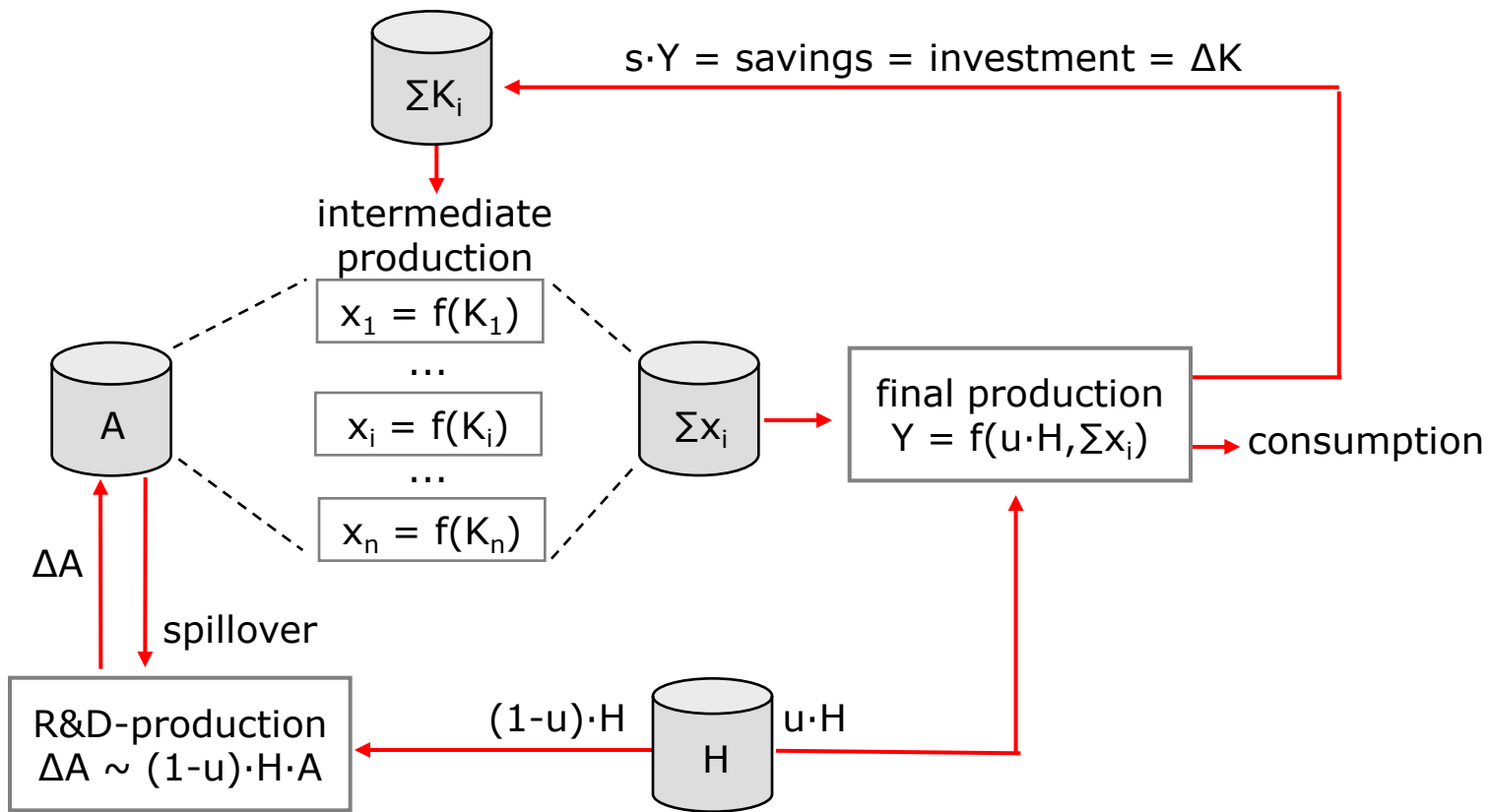
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- international effects
 - no growth effects from trade
 - knowledge diffusion (R&D-spillovers) increases growth rate
 - North-South-models: imitation in the South enhances growth in the innovating North (if no frictions in structural change)
- negative growth effect of learning-by-doing
- basic research is not invariably good (hump shape effect due to opportunity costs in the R&D-sector)
- case of decreasing returns to scale in R&D
 - negative externalities in R&D (rent-seeking)
 - research activity might be too high

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- vertical model of product development (allows for obsolescence of old intermediate inputs \Rightarrow creative destruction)
- R&D production involves labor and capital
- explains increasing R&D-expenditures with constant growth rates
- unbalanced growth paths (driven by expectations on future research), possible no-growth trap
- excessive research possible due to business-stealing effect
- equilibrium growth rate can be greater or less than social optimum

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- combination of R&D and human capital accumulation
 - decreasing returns to scale in R&D (otherwise exploding growth)
 - growth rate still endogenous, but exogenous to political influence
 - R&D-subsidies
 - taxes
 - basic research
 - economic integration (for innovators)
- no effect on steady-state growth rate
- policy advice: concentrate more on the level than on the growth effects

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- no clear picture (lack of robust results due to complex interaction of various influence factors)
- lack of institutions and transaction costs (\Rightarrow NIE)
- no qualitative supply-side restrictions
- problem of exhaustible resources resolved by knowledge (factor augmenting technological change)
- knife-edge problem (saddle path “stability”, linear-homogenous production functions): path between stagnation and exploding growth
- endogenous growth theory: rather conditions for steady-state than explaining the future

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- long-run analysis (steady-state): distinguishes between rate effects that last and those that are transient
- capital accumulation alone does not provide for persistent productivity growth
- learning-by-doing: not plausible enough for permanent growth
- basic research: input for R&D, not for final good productions, hump-shape-effect
- human capital accumulation: does not allow for technological progress
- R&D-models suggest room for political interventions
- the R&D-picture changes in the world of semi-endogenous growth
- omitted here: evolutionary theories (institutional framework for the invention-innovation-diffusion process)

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