

Classical and Neoclassical Growth Models

Development Economics, Lecture 4

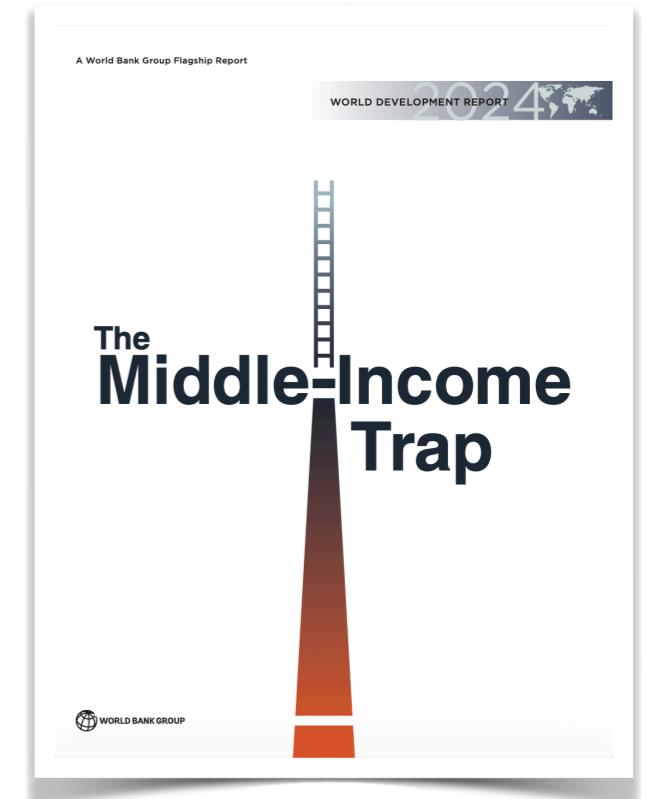
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Outlook

- Mandatory reading illustrates practical relevance
- **Vantage point:** growth important for development
 - Which factors determine the growth rate of an economy?
 - Why do countries' growth rates differ?
 - Can we expect convergence?
- Which aspects do growth models **highlight or obscure?**
- Outline:
 - Part 1: Classical views of growth
 - Part 2: The Solow-Swan Model
 - Part 3: Growth accounting and endogenous growth

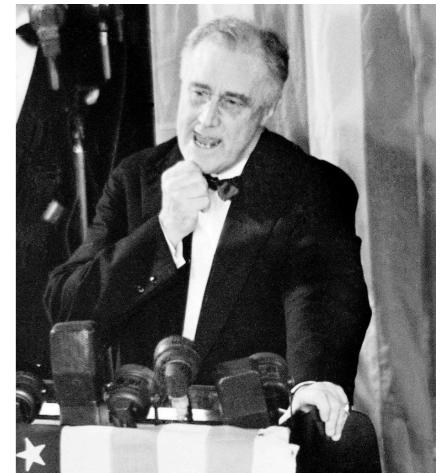


Part 1: Classical Views of Growth

Historical foundations

- Today: Growth as growth of national income a.k.a. GDP
- GDP as such emerged in the mid of the 20th century
 - First ideas: 17th century by William Petty
 - Important contributions: Colin Clark (1932), Simon Kuznets (1933)
 - First time a political goal in US elections of 1938

“ We must start again on a long, steady, upward incline in national income.”



Franklin D. Roosevelt
(1882-1945)

- Few contributions on growth before 1930s/40s: “Statistics without theory”
 - Key contributions: Harrod & Domar (1939, 1946), Arthur Lewis (1954), Trevor Swan & Robert Solow (1956)

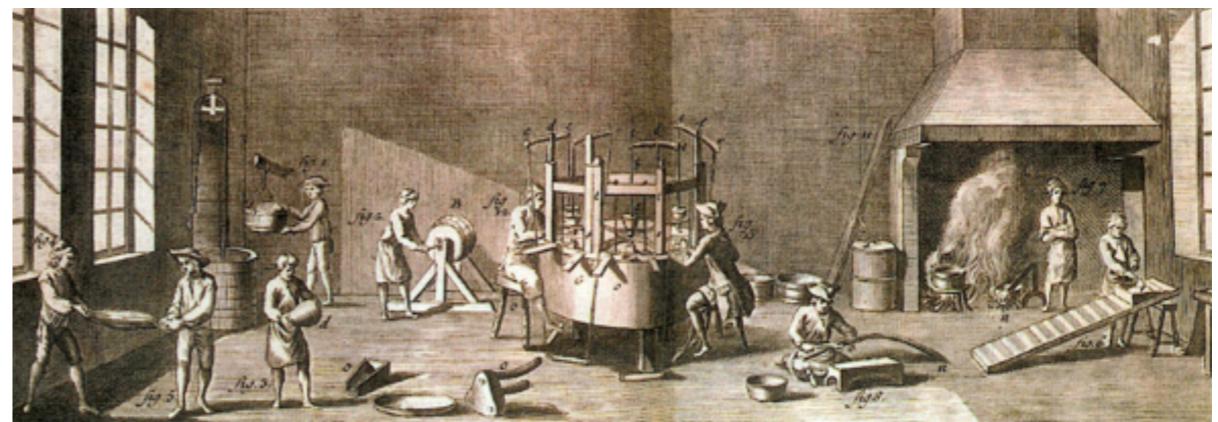
Classical economics and growth

Adam Smith: market size as a limit

- Classical economists more concerned with capitalist dynamics
 - Focus was on limits to development, not growth mechanisms
- Smith: **division of labor** as driver of the wealth of nations
 - Division of labor limited by the size of the market

Smith's pin factory

- One worker: 20 pins/day
- 10 workers: 48,000 pins/day
- Specialization drives productivity



- Small markets do not support high specialization

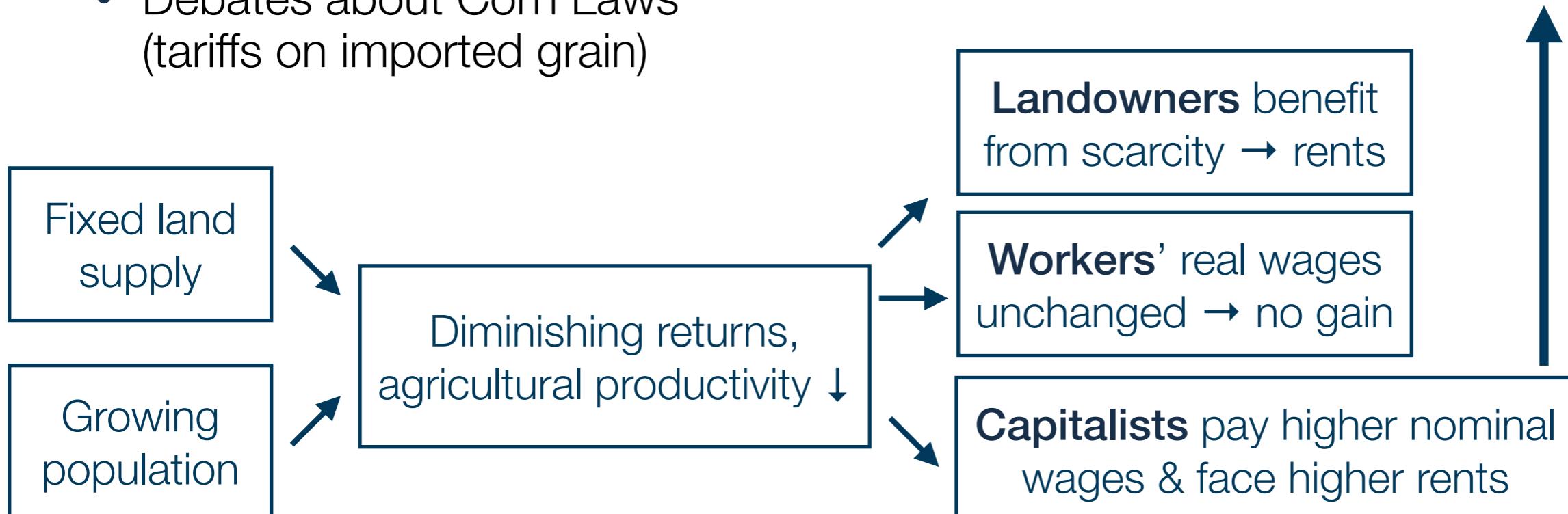
Classical economics and growth

David Ricardo: land as a limit

- Key concern: Can UK feed its growing population when land supply is fixed
- Historical environment:
 - Rapid population growth
 - Rising grain prices
 - Debates about Corn Laws (tariffs on imported grain)

Stationary state

- No incentive to invest (no returns to capital)
- Capital accumulation stops → Economic growth ceases
- All surplus captured by landowners as rent



Classical economics and growth

Karl Marx: the falling rate of profit

- Expanded reproduction a la Marx:

Exploitation: capitalists extract surplus value from workers

Re-invest surplus into more capital → **accumulation**

Expansion

- **Internal contradiction** of capitalism

Competition among capitalists enforces **mechanization**

Economy becomes more **capital-intensive** (c/v rises)

Falling rate of profit

- The falling rate of profit leads to:
 - Declining investment and stagnation
 - Intensifying competition and increasing exploitation
 - Imperialism, war, system-wide crises and revolution

Classical economics and growth

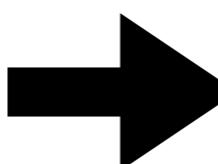
Summary

- Smith, Ricardo and Marx were concerned with **systemic dynamics**
 - No growth theory in the contemporary sense → broader view on society
- Smith and especially Ricardo: **external limits**
- Marx: **internal contradictions** of capitalism
- All highlight **distributional conflicts** of growth and development
- **Technology** as problem solver for Smith & Ricardo,
 - Marx: endogenous to class conflict and source of further problems
- Smith and Ricardo: **limits and stagnation**
- Marx: **endogenous self-destruction** of capitalism

Part 2: The Solow-Swan model

Towards the Solow-Swan Model

The historical vantage point

- First mathematical growth model by Harrod (1939) and Domar (1946)
 - Context: Great Depression, Keynesian revolution, Sputnik
 - Key relationships:
 - $Y = (1/\nu) \times K$
 - $I = \Delta K$
 - $S = s \times Y$
 - $S = I$
 - g : actual growth rate
 - g_w : warranted growth rate
 - g_n : natural growth rate
-
- Steady growth only if $g = g_w = g_n$, otherwise **cumulative instability**
 - **Conclusion:** no self-correction, inherent instability, need for intervention

Towards the Solow-Swan Model

Additional info for the Harrod Domar Model

- Y : Output
 - K : Capital stock
 - v : capital-output ratio (constant)
 - S : total savings
 - s : savings rate
 - I : total investment
- The three growth rates:
 - $g = \Delta Y/Y$: actual growth rate (i.e. empirical observation)
 - $g_w = s/v$: warranted growth rate
 - The growth rate at which entrepreneurs' expectations are fulfilled and they maintain their desired capital-output ratio
 - Full utilization of capital, desired investment equals actual investment
 - $g_n = n + \lambda$: natural growth rate
 - n : growth of labor force; λ : rate of labor-augmenting tech change
 - Exogenous and determined by supply side fundamentals
 - Maximum sustainable growth rate given labor force growth and technological progress

The Solow-Swan Model

- Solved the instability ‘problem’ of Harrod-Domar
 - **Key innovations:** factor substitution and diminishing returns
 - **Implication:** stable growth possible without intervention
 - **Microfoundations:** coefficients not exogenous, but possible derived from microeconomics
- Harrod-Domar: $Y = (1/\nu) \times K$
- Solow-Swan: $Y = F(K, L) = K^\alpha \times L^{1-\alpha}$
 - Allows for **substituting** K for L and vice versa
 - **Diminishing returns** for both factors



Robert Solow (1924-2023)



Trevor Swan (1918-1989)

The Solow-Swan Model

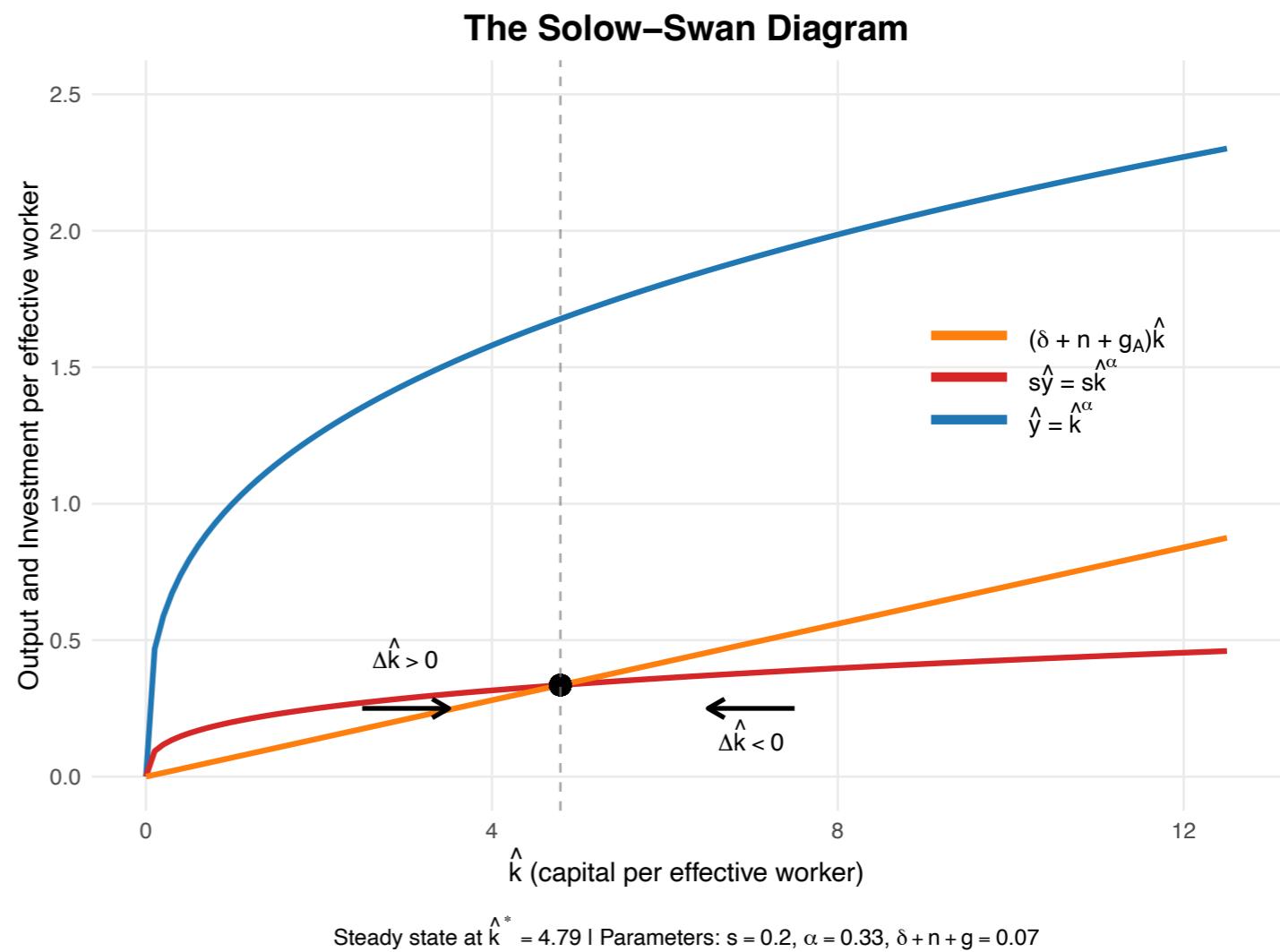
Model details

- **Absolute terms:** $Y = F(K, L) = K^\alpha \times L^{1-\alpha}$
- **Per capita terms:** $y = F(k) = k^\alpha$
 - $y \equiv Y/L$ (output per worker) and $k \equiv K/L$ (capital per worker)
 - Dividing everything by $L \rightarrow L/L = 1$
 - $0 < \alpha < 1$: diminishing returns to capital
- Δk : Investment minus depreciation $\delta \rightarrow$ **equation of capital accumulation**
- $\Delta k = sy - \delta k = sk^\alpha - \delta k$
 - Investment sk^α adds to capital stock, depreciation δk reduces it
 - **Steady state:** investment equals depreciation

The Solow-Swan Model

Finding the steady state

- Set $\Delta k = 0$
- Then: $sk^\alpha = \delta k$
- Solve for $k^* = (s/\delta)^{1/(1-\alpha)}$
- At k^* , y^* is constant
→ no per capita growth
- Absolute growth determined by population growth n
- The actual model also includes technology A :
 - $Y = K^\alpha \cdot AL^{1-\alpha}$
 - Fully exogenous → same effect as population growth
 - Determines total growth, but “falls from heaven”



The Solow-Swan Model

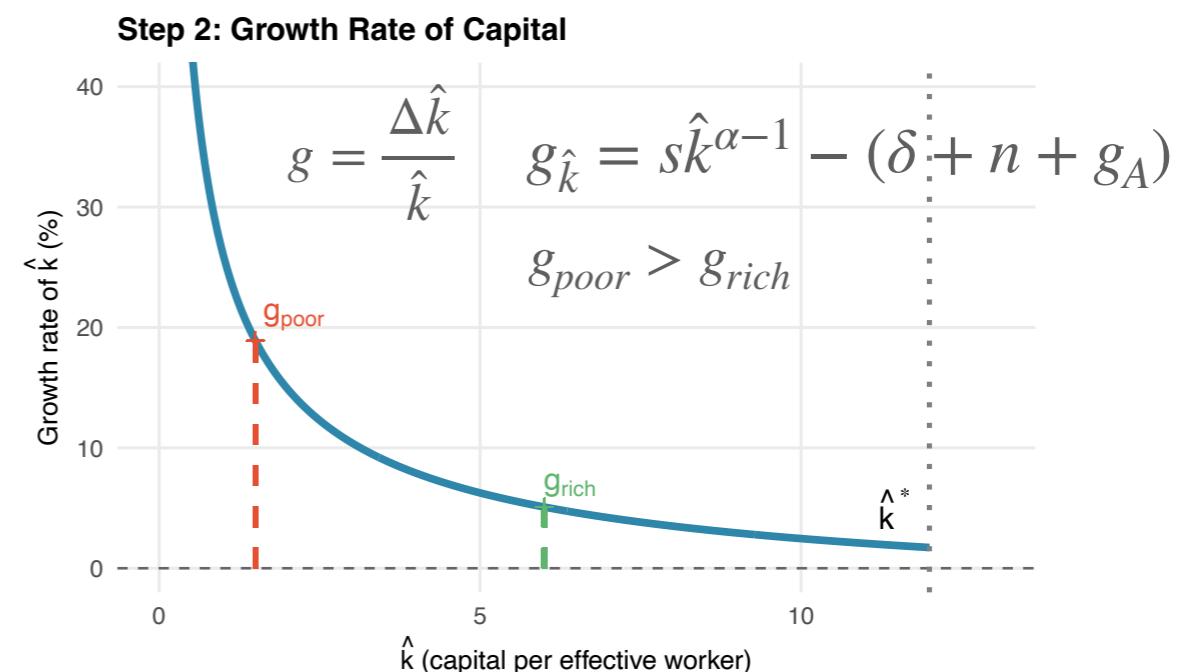
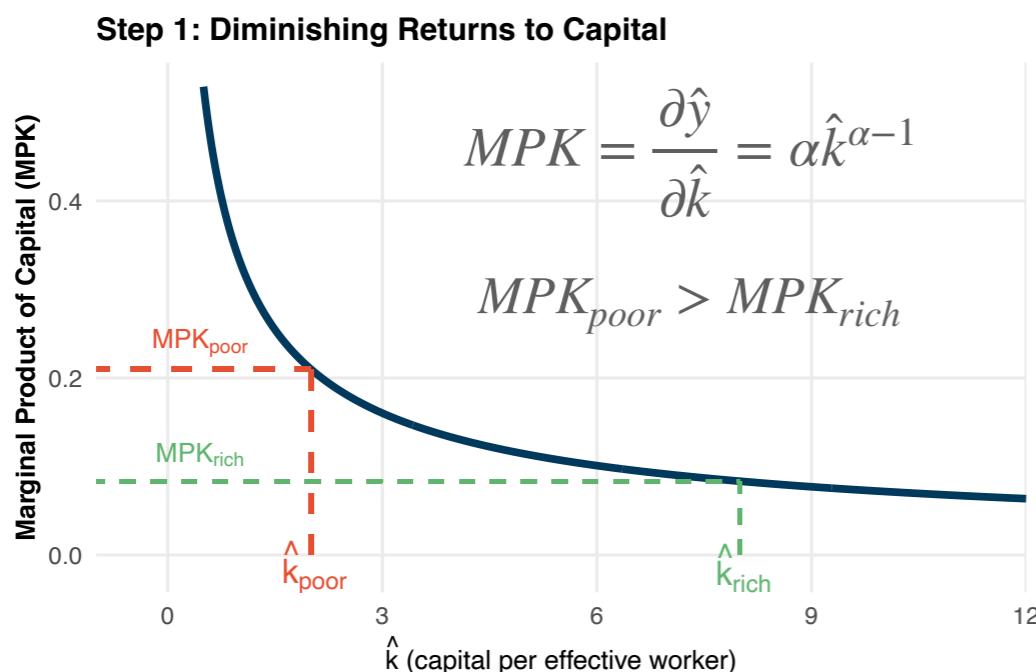
The Context

- **Harrod-Domar:** Great Depression, Keynesianism, planning affinity
- **Solow-Swan:**
 - Post-War prosperity → more consistent with empirical observations
 - **Factor substitution** happens in reality
 - Defence of **market capitalism** during the cold war
 - Free markets can be **self-correcting** without planning intervention
 - Contact to microeconomics → **microfoundations**
- Solow-Swan had then clear scientific advantages...
 - ...but also fitted the then-dominant ideology much better
- Today, which of the two is ‘better’ is debated

The Solow-Swan Model

The view on global inequality

- The Solow-Swan model makes a strong prediction regarding **convergence**



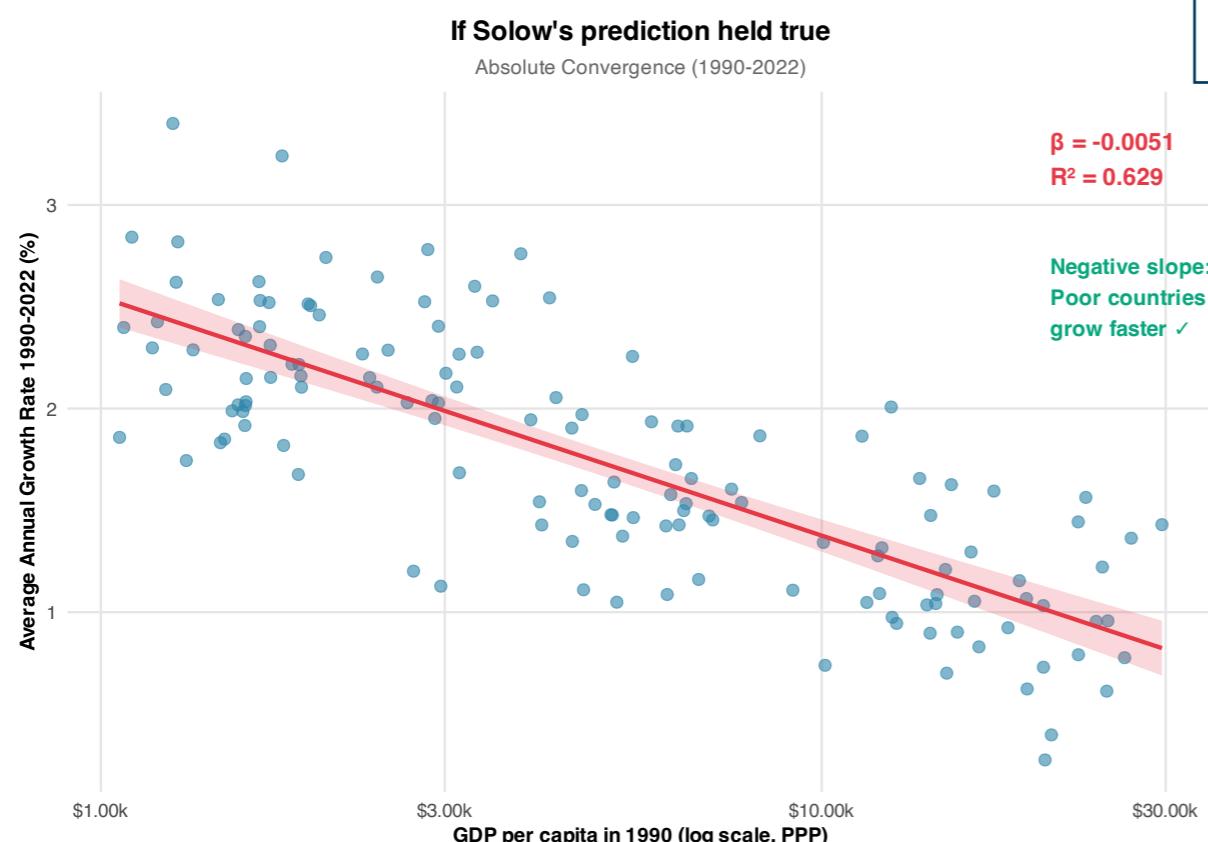
- This prediction has sparked huge empirical literature
 - Absolute convergence:** In the long run, all countries converge to the same per capita income (the Solow-Swan prediction)
 - Conditional convergence:** In the long run, all countries *with the same fundamentals* converge to the same per capita income

The Solow-Swan Model

The view on global inequality

- Test absolute convergence: regress initial GDP on average growth rate:

$$\frac{1}{T} \ln \left(\frac{y_{i,t+T}}{y_{i,t}} \right) = \alpha + \beta \ln (y_{i,t}) + \epsilon_i$$

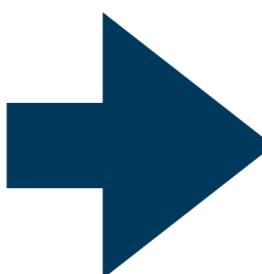


$\frac{1}{T} \ln \left(\frac{y_{i,t+T}}{y_{i,t}} \right)$: Average annual growth rate of GDP per capita over time period T

$y_{i,t}$: Initial GDP per capita

β : Convergence parameter; absolute convergence if $\beta < 0$

T, i : Time period length and country index



Your task
Get data and test the
absolute convergence
claim yourself!
(See course website)

Part 3: Growth Accounting and endogenous growth

Growth Accounting

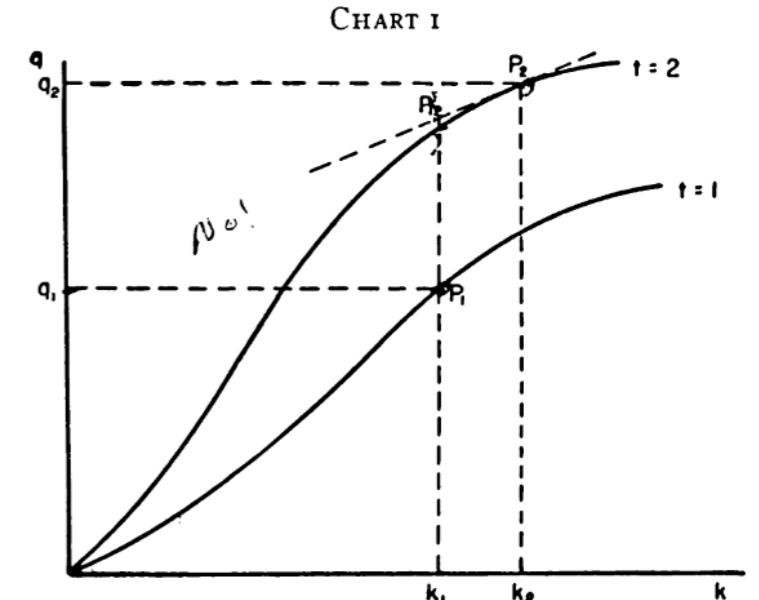
Robert M. Solow

- Key contribution of Robert Solow (1957):

- Decomposes output per worker growth into capital deepening and a residual ('technical change')
- "Movement **along vs. shifts** of the production function"

- Methodological approach:

- Assumes **constant returns to scale**: $Q = F(K, L; t) \rightarrow Q = A(t) \cdot f(K, L)$
- Divide by L for per capita perspective: $q = A(t) \cdot f(k)$ with $q = \frac{Q}{L}$ and $k = \frac{K}{L}$
- Assume **competitive markets** $\rightarrow w_K = \frac{\partial Q}{\partial K} \cdot \frac{K}{Q}$ and $w_L = \frac{\partial Q}{\partial L} \cdot \frac{L}{Q}$ as (observable) income shares
- Then you get growth rates: $g_Q = g_A + w_K \cdot g_K + w_L \cdot g_L$
- Compute the 'residual': $g_A = g_Q - w_K \cdot g_K - w_L \cdot g_L$
 - "**Solow Residual**" \sim Technological change / Total Factor Productivity



Solow's key findings

$$g_Q = g_A + w_K \cdot g_K + w_L \cdot g_L$$

- $w_K \cdot g_K$ and $w_L \cdot g_L$ represent movements **along** the production function
- The “Solow Residual” g_A represents **shifts of** the production function
- Solow’s findings for the US (1909 - 1949):
 - Focus on per capita: $g_q = g_A + w_K \cdot g_K$
 - g_q doubled from 1909 to 1949
 - 12.5% can be attributed to capital deepening (g_K)
 - **87.5%** can be attributed to the **Solow Residual** g_A a.k.a. technical change
 - Technical change was **neutral** over this period

Growth Accounting after Solow (1957)

- Today's growth accounting strategies more complete and sophisticated
- Central result remains stable: **technical change** is the **key driver of growth**
- Unfortunately, it is the least understood component
 - “Solow residual as a **measure of our ignorance**”
- These findings motivated everything in modern mainstream growth theory
 - Endogenous growth theory
 - It is essentially a theory about g_A

A glimpse on endogenous growth theory

- **Human Capital Models** (e.g., Lucas 1988)
 - $$Y = A \cdot K^\alpha \times (hL)^{1-\alpha}$$
 - h as human capital → positive externalities and spillovers → sustained growth
- **R&D Models** (e.g., Romer 1990)
 - Ideas as drivers of technical change
 - Ideas are non-rival, partially excludable and feature increasing returns
- **Learning-by-doing models** (e.g., Arrow 1962)
 - Productivity improves with experience
 - Learning-by-doing potentially differs across sectors (manufacturing > agriculture)
- All these theories have been unsuccessful in fully explaining g_A
 - Heterodox approaches such as evolutionary economics more promising (?)
 - More details in the seminar Development Studies

Part 4: Summary and Outlook

Summary and outlook

- The Solow-Swan model was a catalyst for growth theory
 - Stable growth is **feasible** (contra Harrod-Domar)
 - Growth is driven by technical change → **endogenous growth theory**

Highlights:

- Key role of technological change
- Role of capital accumulation and investment
- Relevance of savings and productivity
- Mechanisms of (non-)convergence
- Instrumental value of education and innovation

Obscures:

- The mechanisms of technical change
- Distribution and inequality (\neq classics)
- International power relations and historical path dependencies
- Environmental implications and limits
- Institutions, sectoral composition, and heterogeneity of capital

Outlook

- Mainstream growth models must be **complemented** by other approaches
- **Institutional and evolutionary approaches** (Sessions 5 and 7)
 - Institutions explain technological change and global inequality
- **Marxist and dependency approaches** (Session 6)
 - In capitalism, development depends on underdevelopment elsewhere
 - Imperialism, exploitation, and unequal exchange as systemic problems
- **Ecological economics and degrowth** (Session 8)
 - Systematic relationship between growth and environmental problems
 - Technical change might not save us, growth as problem rather than solution