

ME2720 Macroeconomics for Business

Lecture 3

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November 6, 2017

Outline

- 1 Last Lecture!
- 2 Total Factor Productivity (TFP)
- 3 Human Capital
 - Data on Human Capital
- 4 Sources of Prosperity
- 5 Institutions
 - Data on Institutions
 - The Korean Experiment
 - The Colonial Experiment
- 6 Technological Progress
- 7 Exogenous vs. Endogenous Growth
- 8 Poverty Traps
- 9 Convergence
- 10 Determinants of the Steady State
- 11 AID
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- **Economic growth** and its importance
- The (Cobb-Douglas) **production function** and the role of **returns to scale**
- **Growth transitions**: initial reliance on labor and latter stronger dependence on capital and TFP
- **Capital accumulation** and **convergence**
- The **steady state** (i.e. when $I = \delta K$), **transition dynamics** and **investment rates**
- The **golden rule**, i.e. the steady-state level of capital that maximizes consumption per worker

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What is TFP?

- Recall the (Cobb-Douglas) production function:

$$Y = f(A, K, L) = AK^\alpha L^{1-\alpha}$$

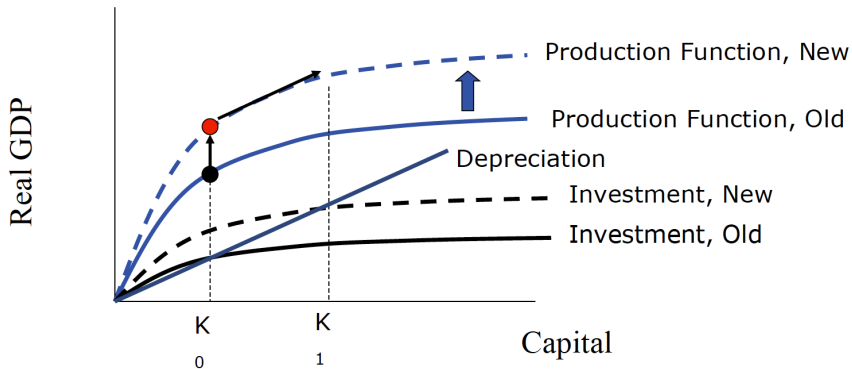
- **TFP**, denoted A and thought of as the “*efficiency parameter*”, captures the influence of any factor other than K and L on Y

$$A = \{\text{technology, institutions, education, \dots}\}$$

- **TFP role:**
 - ★ The most important source of long-run growth
 - ★ It allows explaining differences in GDP pc

Impact of TFP on growth

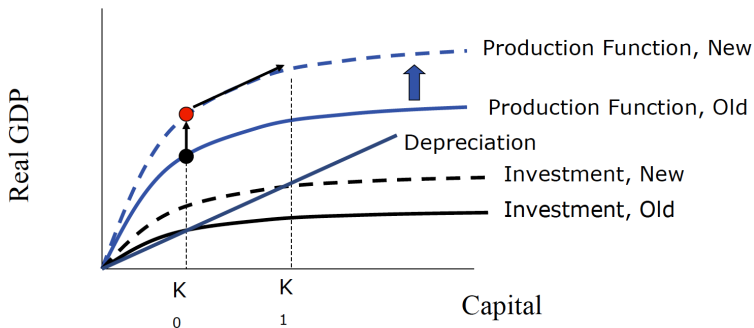
Assume TFP increases because of the introduction of a new technology. Then, the production function shifts upwards, i.e. keeping K fixed more output Y can be produced



Impact of TFP on growth

Direct- & Indirect- Effect of TFP increases

- 1 **Direct effect:** since A is higher, for given capital K we get more output Y
- 2 **Indirect effect:** since Y is greater now, for the same investment rate there is a new steady-state of capital and output

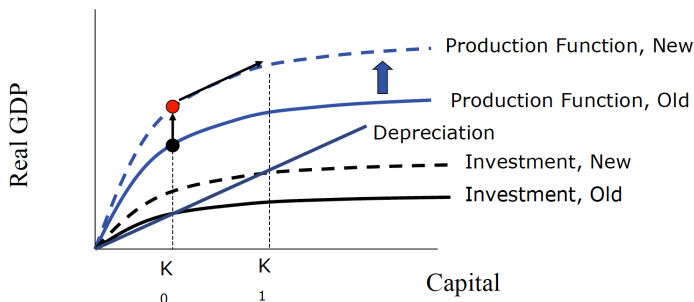


Impact of TFP on growth

Technology adoption and the role of institutions

Countries that adopt the latest technologies and have efficient institutions will reach the **TFP frontier**, i.e. highest feasible level of output Y for given level of capital K

- ... however, few countries reach this point because of geography, corruption, vested interests, etc.



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Definition 1 (Human Capital).

Human capital refers to all the attributes (skills, knowledge, etc.) of workers that potentially increase their productivity in all or some productive tasks.

- Human Capital Theory, mainly developed by Becker (1965) and Mincer (1974), concerned with:
 - ★ the role of HC in the production process
 - ★ incentives to invest in skills: pre-labor market (schooling) and on-the-job investments (training)
- As physical capital, HC also depreciates
- When HC is introduced in the model

$$Y = f(A, K, L, HC)$$

the importance of A diminishes, i.e. it captures less phenomena

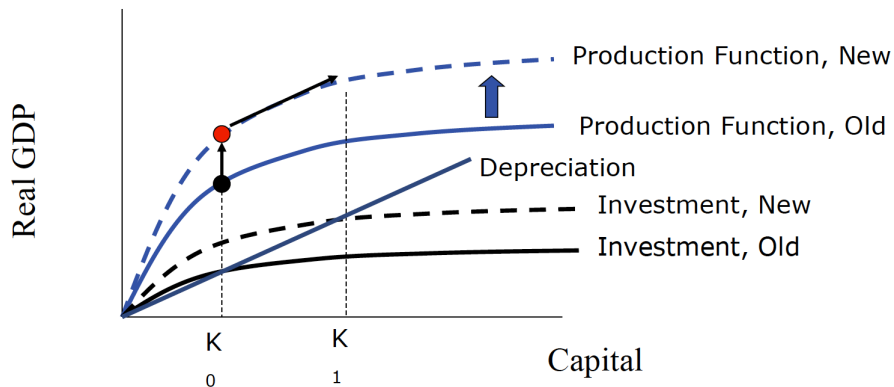
Human Capital

- Important connection between HC and economic growth:
 - ★ Through its effect on technological progress
- Increases in HC boost labor productivity

$$\begin{aligned} \text{GDP pc} &= \frac{\text{GDP}}{\text{Population}} \\ &= \underbrace{\frac{\text{GDP}}{\text{Hours}}}_{\text{Labor Productivity}} \times \underbrace{\frac{\text{Hours}}{\# \text{ Employed}}}_{\text{Avg. Hours Worked}} \times \underbrace{\frac{\# \text{ Employed}}{\text{Labor Force}}}_{\text{Employment Rate}} \times \underbrace{\frac{\text{Labor Force}}{\text{Population}}}_{\text{LF Participation Rate}} \end{aligned}$$

Introducing Human Capital into the Model

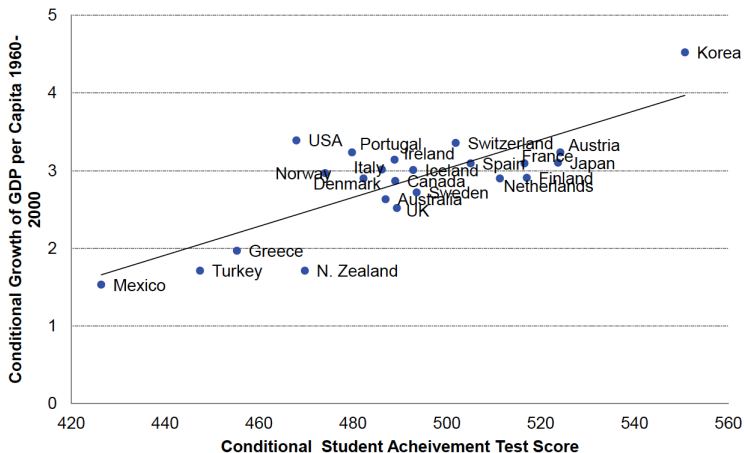
- 1 Boosts in HC (*also*) shift the production function upwards!



Introducing Human Capital into the Model

More educated countries present higher growth rates!

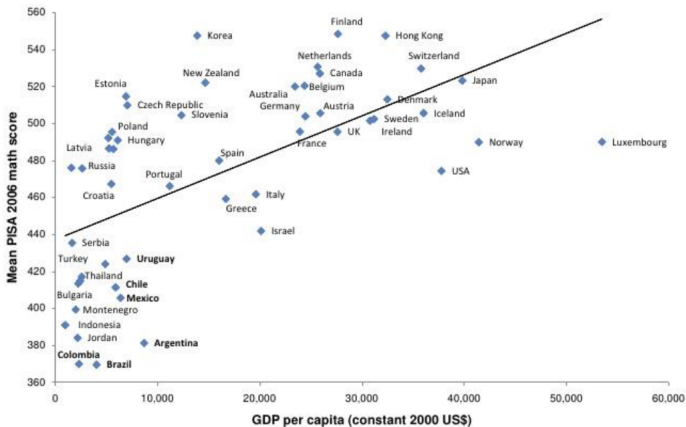
Figure: Avg. annual growth rates vs. test scores, 1960-2010



Introducing Human Capital into the Model

- 2 Boosts in HC (*also*) increase steady-state levels of output and capital

Figure: Positive relationship between education and GDP per capita



Introducing Human Capital into the Model

- ③ Boosts in HC may explain (part of) cross-country growth differentials and investment flows

- **Growth differentials**

- ★ Keeping A, K, L constant, growth is still possible through increases in HC
- ★ Economies with same A, K, L but different HC will present different growth rates

- **Investment flows**

- ★ Consider 2 countries, Sweden and Gambia, with capital stocks K_{high} and K_{low} , respectively
- ★ Given the crucial role of DRS , one might (at first) think that Gambia should receive higher investment flows than Sweden since

$$MPK_{Gambia} > MPK_{Sweden}$$

- ★ Empirical research, however, does not support this reasoning
- ★ Other influences on MPK_{Sweden} offset the role of DRS , e.g. K could be augmented by HC

Extended Growth Accounting Exercise

... and the Contribution of *HC* to GDP Growth

TABLE 5.1 Contribution of Education to Annual Output Growth 1950–90
Human capital helps explain long-run trend growth.

	France	Germany	Japan	U.K.	U.S.
Annual Growth (%)	5.04	5.92	9.27	3.03	3.65
Capital	2.40	3.19	4.33	2.40	1.62
Labor—Hours	−0.09	0.01	0.89	−0.09	0.58
Labor—Skills	0.39	0.19	0.52	0.20	0.48
Total Factor Productivity	2.34	2.53	3.53	0.52	0.97

Source: Crafts, “Productivity Growth Reconsidered,” *Economic Politics* (1991) vol. 15, pp. 387–426.

On the Importance of Human Capital

- Differences in HC help explaining differences in GDP per capita across countries
- Higher HC , *ceteris paribus*, higher output and higher steady-state levels
- Investing in education may be a good idea to promote long-run growth if growth through capital or TFP is difficult (**especially relevant for developed countries!**)
- HC may offset the effects of DRS in capital if, as suspected, HC augments K .
- Differences in HC may also help to understand differences in investment flows, e.g. Sweden vs. Gambia

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Some Data on Human Capital

Developed countries: nearly 100% vs. **developing countries:** 70 – 90%

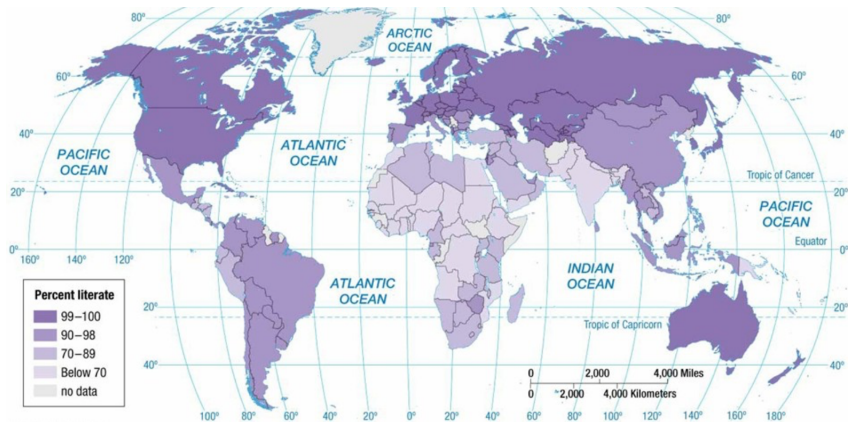


Figure: Literacy rates, 2013

Some Data on Human Capital

In most EU- countries, as well as in Latin- and North- America, completion rates are higher than 95%. However, most sub-Saharan African countries present completion rates well below 50%

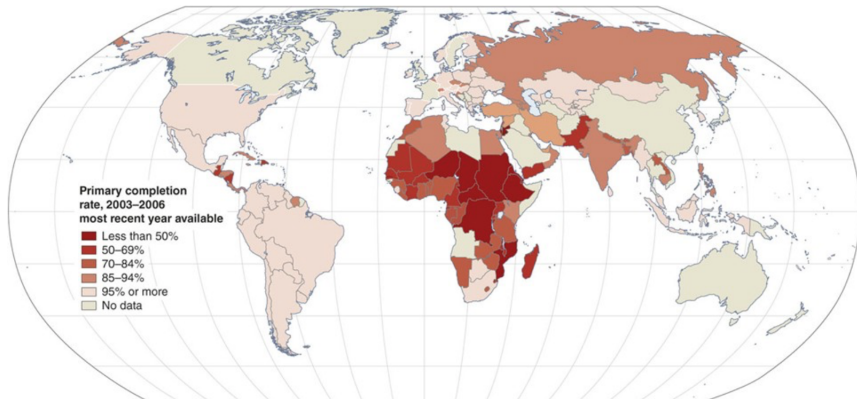


Figure: Primary school completion rates, 2001-2003

Some Data on Human Capital

Highest: US and Germany (12.9), UK (12.3), South Korea (11.8), Japan (11.5); **Lowest:** Ethiopia (2.4) and Congo (3.1)

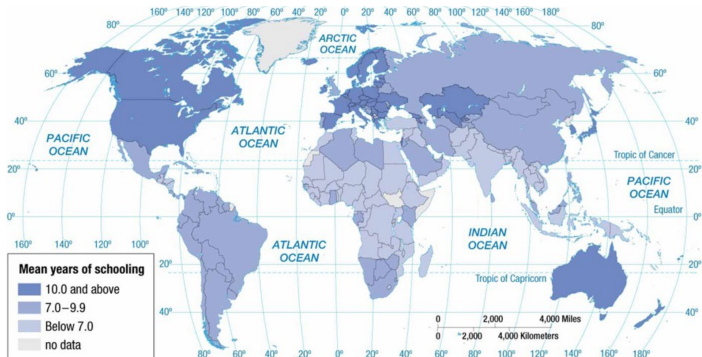


Figure: Avg. years of schooling, 2013

Are avg. years of schooling so important? role of educational systems?

Some Data on Human Capital

Avg. pupil/teacher ratios in primary education: **World** (23.4), **low income** (41), **middle income** (24), **high income** (14), **highest** (Malawi, 70), **lowest** (Liechtenstein, 8), **Sweden** (12)

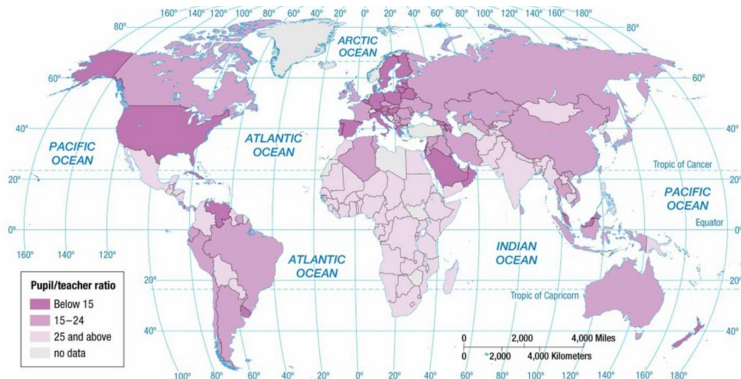
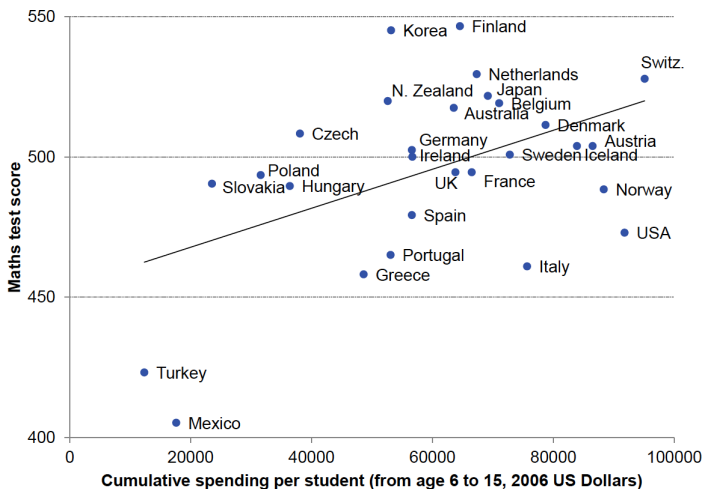


Figure: Pupil/teacher ratio, 2015

Some Data on Human Capital

Remarkable variations in the data indicate that how funds are allocated matters!



Some Data on Human Capital

Empirical research points out to **invested time** (instructional time, homework) and **resources** (libraries, books) as the most important factors contributing to *HC*

Figure: Determinants of Efficient Education Expenditure

	Number of Studies	Positive and Significant Relation	Confirmation Percentage
Primary Schools			
Teacher's salary level	11	4	36.4
School teacher–pupil ratio	26	9	34.6
Teacher's years of schooling	18	9	50.0
Teacher's experience	23	13	56.5
Class instructional time	17	15	88.2
Class frequency of homework	11	9	81.8
School library	18	16	88.9
School textbooks	26	19	73.1
Secondary Schools			
Teacher's salary level	11	2	18.2
School teacher–pupil ratio	22	2	9.1
Teacher's experience	12	1	8.3
Class instructional time	16	12	75.0
School textbooks	13	7	53.8

Source: Fuller and Clarke, 'How to Raise the Effectiveness of Secondary Schools? Universal and Locally Tailored Investment Strategies', Educational and Social Policy Discussion Paper Series No. 28 (Washington, DC: World Bank, 1994).

More on the Importance of TFP

The Crucial Role of TFP

Differences in TFP, after subtracting HC from it, still account for much of the differences in output per worker across countries

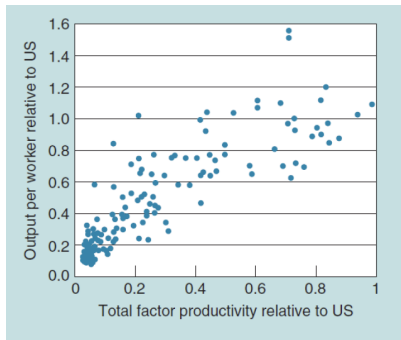


Figure: Output and TFP

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Sources of Prosperity

- Vast differences in incomes per capita across countries. . . why?
- Standard answers:
 - ★ **Physical capital** (poor countries don't save enough)
 - ★ **HC** (poor countries do not invest enough in education and skills)
 - ★ **Technology** (poor countries do not invest enough in R&D, do not adopt new technologies, etc.)
- North and Thomas (1973): **these factors** (innovation, capital accumulation, education) **are not causes of growth**, *they are growth*
- Proximate vs. fundamental causes of growth

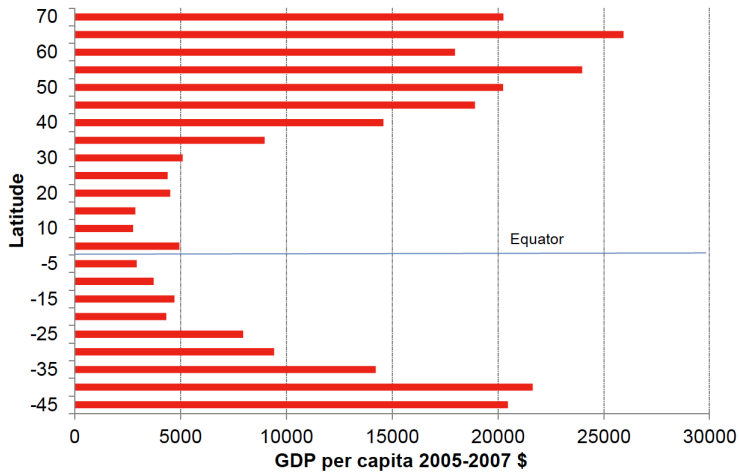
Major candidates to fundamental causes of growth:

- 1 **The luck hypothesis**
- 2 **The geography hypothesis**
- 3 **The culture hypothesis**
- 4 **The institutions hypothesis**

- 1 **The luck hypothesis:** possible but highly unlikely!
 - ★ Consequences of multiple equilibria, e.g. in tech adoption
- 2 **The geography hypothesis** emphasizes the role of nature
 - 1 Climate determines work effort and incentives to produce (Montesquieu, 1748; Marhsall, 1890)
 - 2 Ecology and technology: soil quality, natural resources, topography, technology in temperate- vs. tropical- climates (Myrdal, 1968; Sachs, 2001)
 - 3 Disease burden: tropics more sensible to diseases, e.g. malaria, AIDS (Sachs, 2000)

Sources of Prosperity

Geography: The Importance of Climate

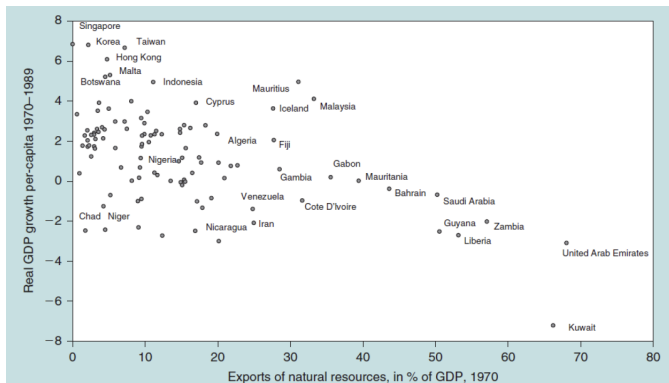


Sources of Prosperity

Geography and the Resource Curse

The Resource Curse

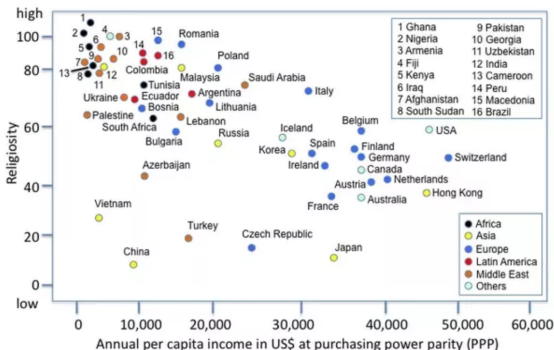
The **resource curse**, or **paradox of plenty**, as an explanation of why countries with great natural resource wealth (oil, gas, minerals) tend to grow more slowly than resource-poor economies



Sources of Prosperity

3 The culture hypothesis: beliefs, values, religions affect economic outcomes

- willingness to engage in productive activity vs. leisure
- degree of cooperation and trust
- Protestantism vs. Catholicism (Weber, 1930; 1958)
- Southern- vs. Northern- Italy (Banfield, 1958)



- ④ **The institutions hypothesis:** institutions shape economic incentives to invest in technology, physical capital, HC, etc.
 - Knack and Keefer (1995), Hall and Jones (1999), Acemoglu, Johnson and Robinson (2001, 2002)
 - Connection between institutions and culture
 - Institutions are *endogenous*

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Literature on Institutions

- “Old” institutional economics flourished in 1920s-1930s ([Veblen](#), [Mitchell](#), [Commons](#))
- 1940-1970: institutions, almost a prohibited subject (in economics)
- New Institutional Economics (NIE) *vaguely* took shape in 1970s.
- NIE, one of the most prolific literatures in economics since 1990s
- NIE, beyond “old” institutional- and neo-classical- economics:
 - ★ In contrast to the old school, NIE does not aim to replace standard theory ...
 - ★ ... but rather to complement neo-classical models, e.g. institutions not taken as *exogenous*
- **Founders:** Ronald Coase ([1937](#), [1960](#)), Oliver Williamson ([1975](#), [1985](#)), Douglas North ([1981](#), [1990](#))
- **Important contributions:** Hall and Taylor ([1996](#)), Hall and Jones ([1999](#)), Acemoglu and Robinson ([2000](#), [2002](#), [2005](#))

Douglas North's (1990) Definition of Institutions

Institutions are the rules of the game in a society or, more formally, the humanly devised constraints that shape human interaction. They structure incentives in human exchange, whether political, social or economic.

Three important elements in this definition. Institutions are:

- ① **Humanly devised:** man-made factors, i.e. societies' own choices
- ② Set **constraints** on individual behavior via:
 - ★ formal rules: constitutions, laws, PRs. . .
 - ★ informal rules: customs, taboos, traditions, etc.
- ③ **Shape interaction and incentives**

Institutions play an important role in:

- Enforcing property rights (PRs)
- Setting limits to firms' power, e.g. anti-monopoly laws
- Establishing political rights
- Fighting corruption
- Providing social insurance
- Macroeconomic stabilization

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Data on Institutions

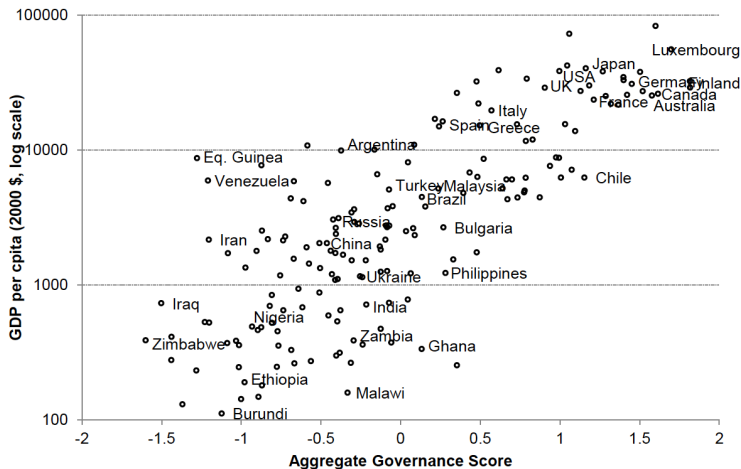


Figure: Governance and GDP per capita

Data on Institutions

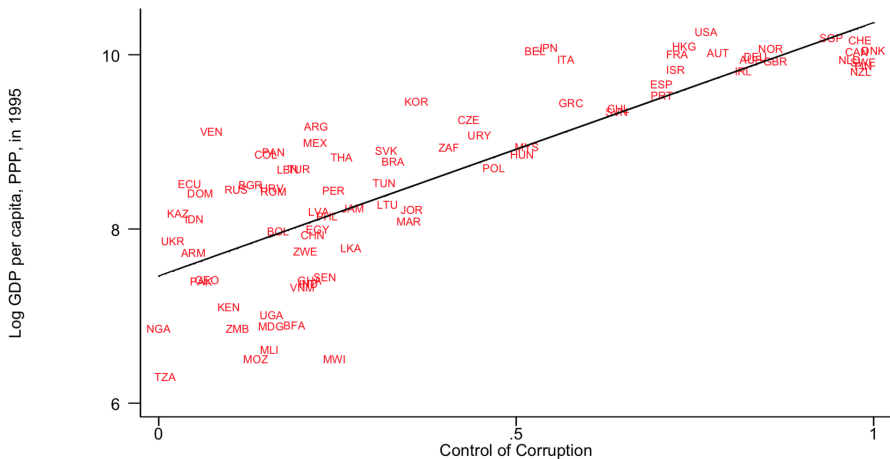


Figure: Corruption and GDP per capita

Data on Institutions

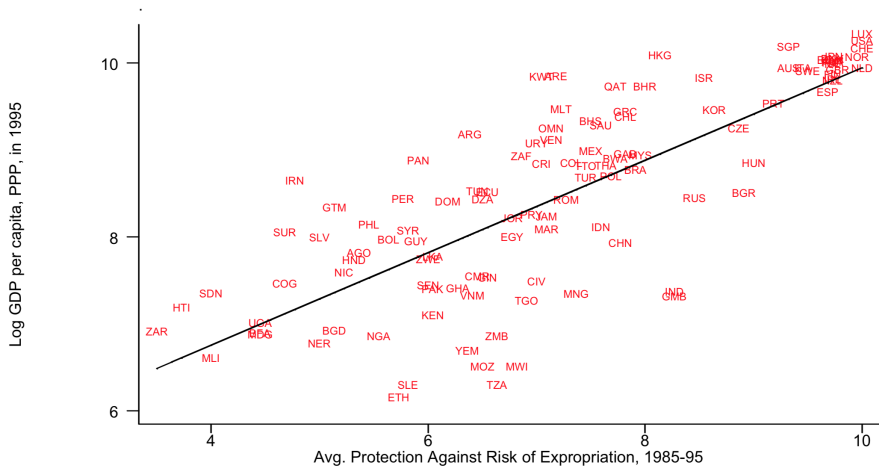


Figure: Enforcement of PRs and GDP per capita

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The Korean Experiment

- **Korea:** economically, culturally and ethnically homogenous at the end of WWII
- If anything, the North more industrialized and richer resources
- **Exogenous shock:** separation of North and South
- Radically different political- and economic- institutions:
 - ★ North: Communism
 - ★ South: Capitalism
- Implications for growth?

The Korean Experiment

Huge differences in GDP per capita

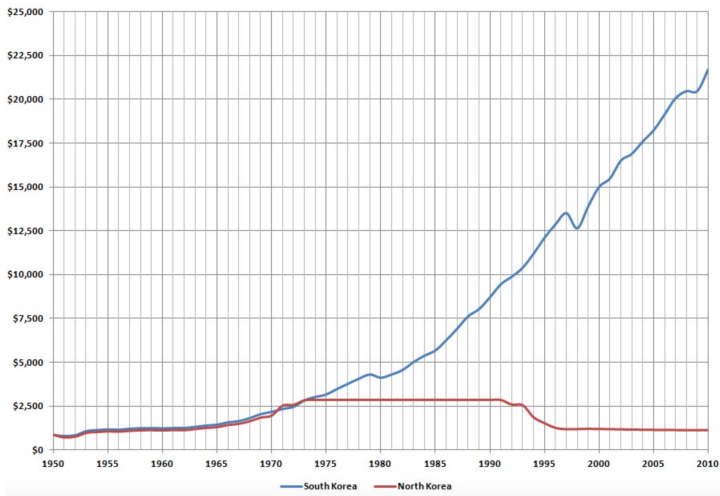


Figure: Real GDP per capita, 1950-2010

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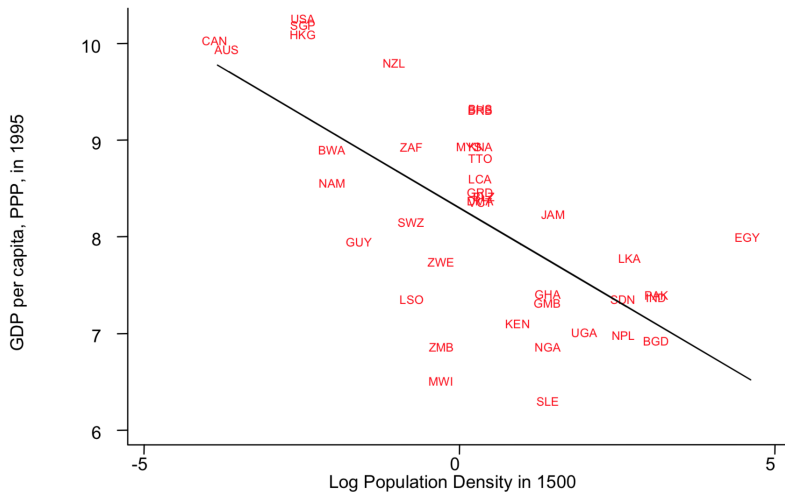
The Colonial Experiment

- Europeans colonized much of the world after 1492
- Colonizers transformed institutions:
 - ★ “Good” institutions where:
 - climate favorable
 - mortality rates low
 - sparse areas
 - ★ “Bad” institutions, i.e. rent-seeking, where:
 - climate adverse
 - mortality rates high
 - high population density
- **Long-run effects:** institutions persisted affection the evolution of income

The Colonial Experiment

In areas with low population density “good” institutions were installed and

...



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Technological Progress

- Technological progress as a source of prosperity
- Endogenous growth models (Romer, 1990; Jones, 1995) incorporate technological progress through R&D
- R&D, technological progress, the production function, and the “forever-shifting” steady state
- As countries approach steady states they have more incentives to invest in R&D since:
 - ★ growth from capital accumulation is difficult (*Decreasing MPKs*)

Technological Progress

As a country approaches its steady state, it invests more on R&D

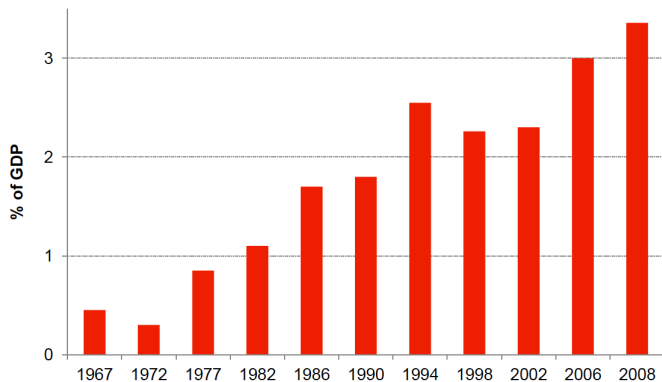


Figure: South Korean R&D as % of GDP

Technological Progress

Rich countries spend more on R&D

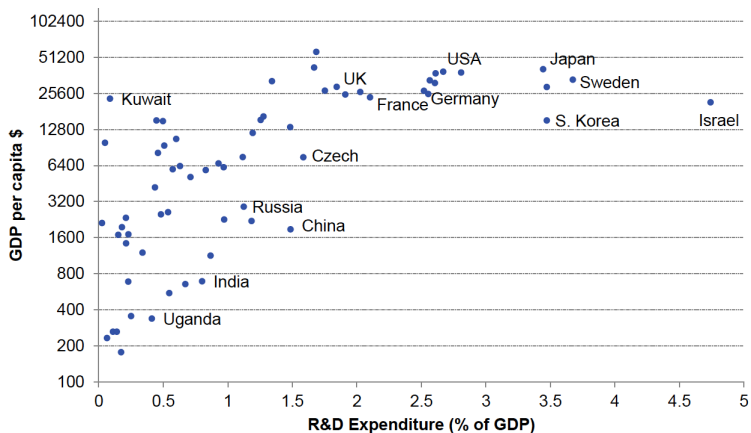


Figure: GDP per capita and R&D spending

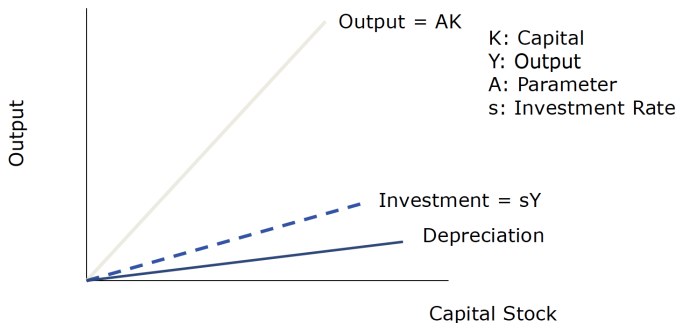
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- 1 **Neoclassical/Exogenous Growth:** the long-run growth rate is *exogenously* determined by either the savings rate ([Harrod-Domar model](#)), the rate of technological progress ([Solow-Swan model](#)), or some other unexplained factor.
- 2 **Endogenous Growth:** models explicitly the key determinants of long-run growth
 - ★ These models drop the assumption of diminishing MPK
 - ★ Simplest Model: The AK Model (Frankel, [1962](#))
 - ★ Human Capital: Romer ([1986](#)), Lucas ([1988](#)), Rebelo ([1991](#))
 - ★ Technological Change: Romer ([1990](#)), Grossman and Helpman ([1991](#)), Aghion and Howitt ([1992](#)), Jones ([1995](#))

Endogenous Growth

The AK Model

- Instead of DRS assume CRS in capital K , i.e. $\alpha = 1$
 - ⇒ Production- and investment- functions become straight lines
 - ⇒ **No steady state**: investment and depreciation lines do not intersect
 - ⇒ Investment $>$ depreciation, capital stock always growing and growth does not slow down



Endogenous Growth

Implications of the AK Model

- The absence of the steady state rules out convergence
- Room for government intervention:
 - ★ Change in capital stock

$$\Delta K = I - D = sY - \delta K = sAK - \delta K$$

- ★ Growth in capital stock

$$\frac{\Delta K}{K} = \frac{sAK}{K} - \frac{\delta K}{K} = sA - \delta$$

- ★ Since increases in capital stock depend on the investment rate s , affecting s will increase both the *levels* and the *growth rate*

Endogenous Growth

A (slightly) more-complex model of endogenous growth

- Empirical evidence: capital income about 30% of GDP, i.e. $\alpha \approx 1/3$
 - ★ But... $\alpha = 1/3$ in the standard model \Rightarrow diminishing *MPK*
- Is then, with $\alpha \approx 1/3$, endogenous growth possible?
 - ★ **YES!** if *K* is augmented by some other factor, e.g. *HC*
- Extended model:

$$Y = f(A, K, L, HC) = AK^\alpha(HC)^\beta L^\xi$$

- Decreasing MPs:

$$MP_{HC} = \frac{\partial Y}{\partial HC} = \beta A(HC)^{\beta-1} K^\alpha L^\xi = \beta \left(\frac{Y}{HC} \right)$$

$$MP_K = \frac{\partial Y}{\partial K} = \alpha A(HC)^\beta K^{\alpha-1} L^\xi = \alpha \left(\frac{Y}{K} \right)$$

Endogenous Growth

A (slightly) more-complex model of endogenous growth

- Assume now that HC and K augment each other, e.g. $HC = DK$

$$\begin{aligned} Y &= f(A, K, L, HC) = AK^\alpha(HC)^\beta L^\xi \\ &= AD^\beta K^{\alpha+\beta} L^\xi \end{aligned} \tag{1}$$

- Then

$$MPK = \frac{\partial Y}{\partial K} = (\alpha + \beta) \left(\frac{Y}{K} \right)$$

- MPK constant *iff*

$$\alpha + \beta = 1$$

- This reconciles the empirical evidence: despite $\alpha = 1/3$, if $\beta = 2/3$, MPK could be constant

Endogenous Growth

MPK and the Complementarity of Human- and Physical- Capital

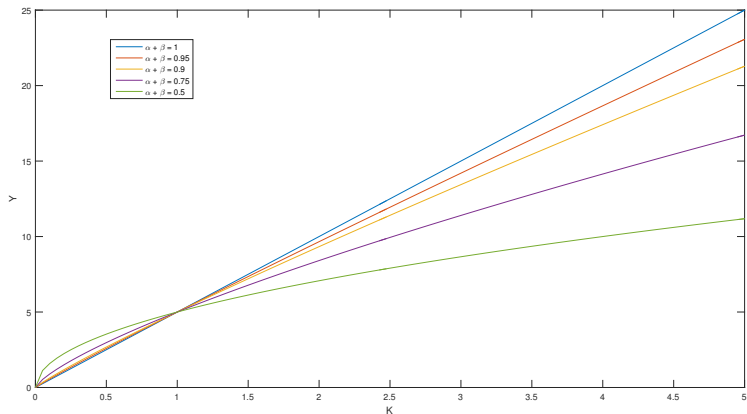


Figure: $Y = CK^{\alpha+\beta}$, for β fixed and $C \equiv AD^{\beta}L^{\xi} = 5$

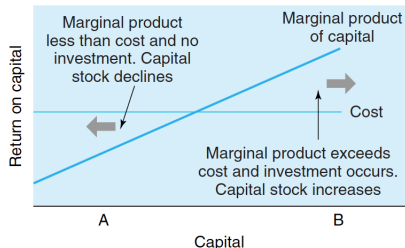
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Poverty Traps

Poverty Trap

A **poverty trap** is a self-reinforcing mechanism where an economy, caught in a vicious cycle, suffers from persistent underdevelopment

- Increasing MPKs could explain existence of poverty traps
 - ★ No convergence, but **divergence**: rich get richer, poor get poorer!
 - ★ Empirical evidence documents the existence of poverty traps
- Poverty traps as “low-level” equilibria



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- Different assumptions about MPK \Rightarrow different implications for growth, including convergence
- The “convergence phenomenon”:
 - ★ **Neoclassical growth**: predict convergence, i.e. countries “catch-up”
 - ★ **Endogenous growth**: predict divergence, i.e. widening gaps
- Types of convergence:
 - 1 **Absolute convergence**
 - 2 **Conditional convergence**

Convergence

Absolute Convergence

Poor countries grow faster than rich ones without conditioning on any initial characteristics, i.e. countries share the same steady state.

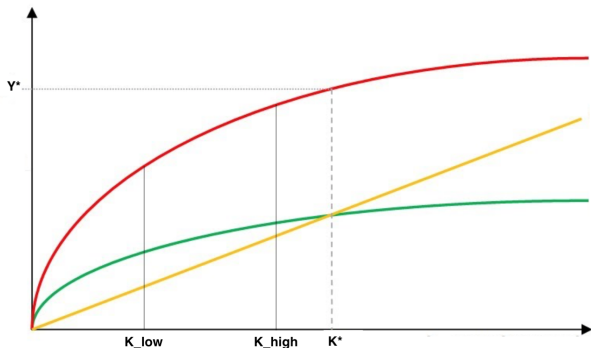


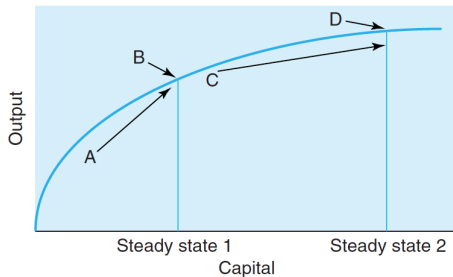
Figure: Absolute convergence

Convergence

Conditional Convergence

Poor countries grow faster than rich ones conditional on some initial characteristics (investment rates, education, etc.), i.e. only if they share the same steady state.

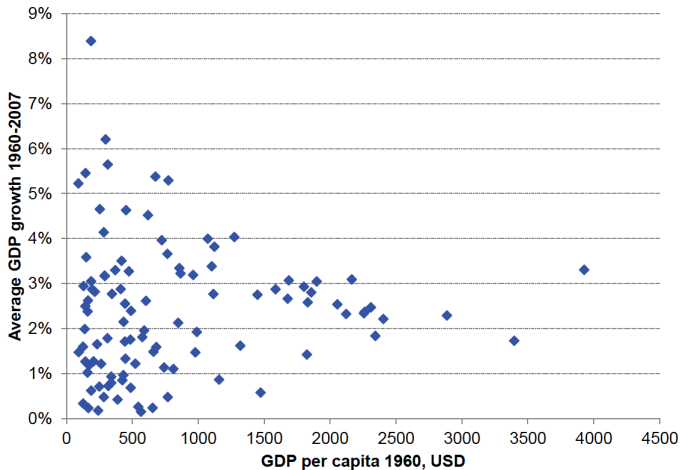
No overall convergence, but convergence within groups!



Convergence

A quick look at the data

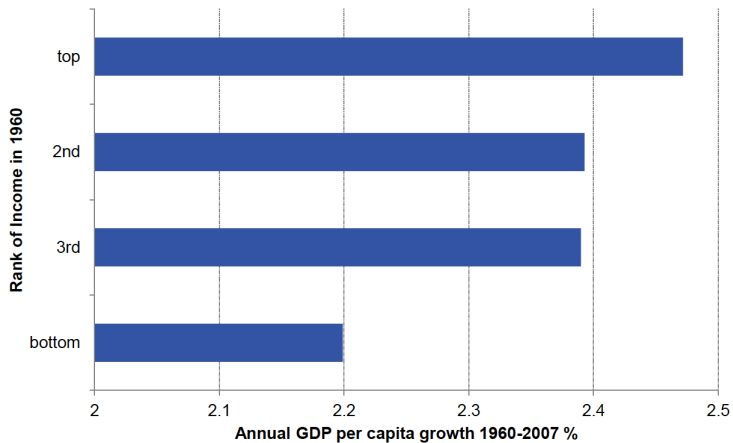
No signs of absolute convergence!



Convergence

A quick look at the data

... but rather divergence!



Convergence

A quick look at the data

Evidence of **conditional convergence**!

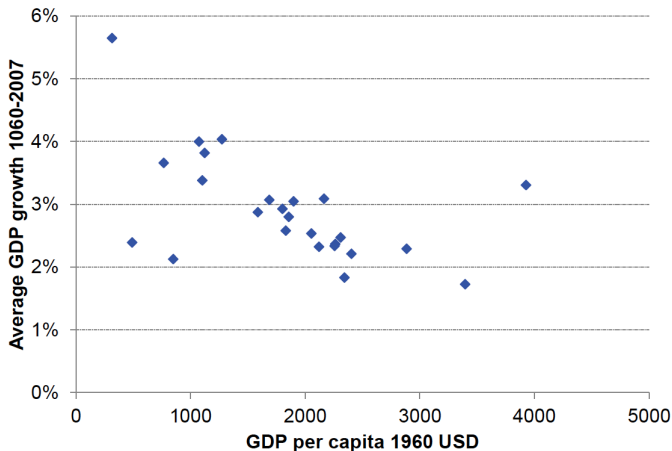


Figure: Convergence across OECD economies

Convergence

A quick look at the data

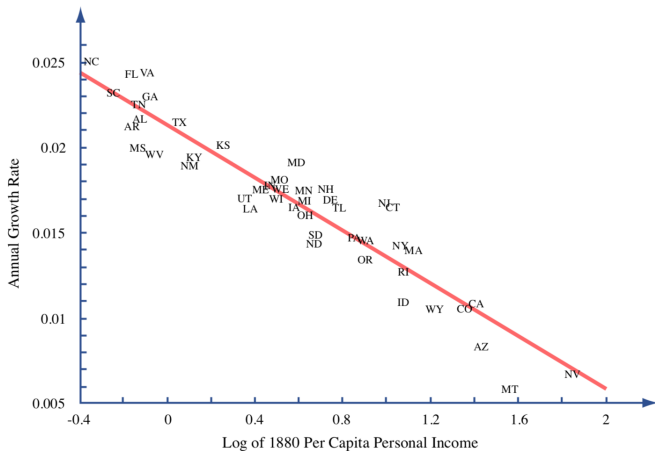


Figure 4

Figure: Convergence across US states, 1880-2000

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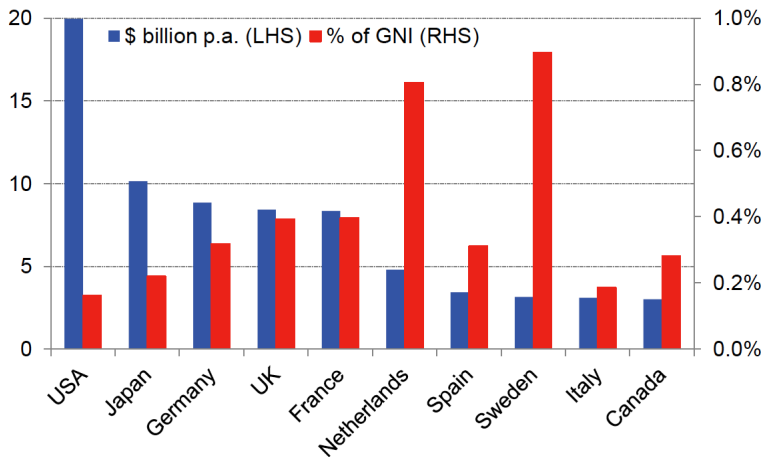
Steady-state Determinants

- Level of investments and savings
- Accumulation of human capital (education)
- Government policies
- Institutions (PRs, corruption, crimes, etc.)

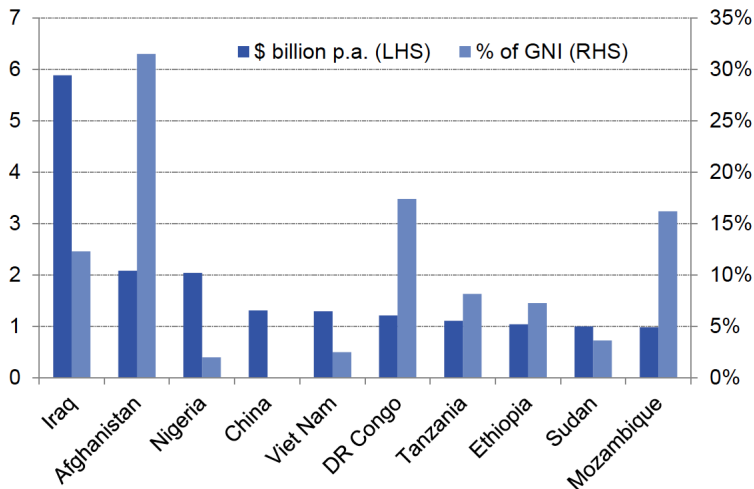
Always Significant	Frequently Significant	Often Significant	Sometimes Significant
Education – primary school enrolment	Regional dummies (Latin America, Sub-Saharan Africa – negative)	Real exchange rate overvaluation (negative)	Government consumption (negative)
Investment	Rule of law	Black market premiums (negative)	Financial sophistication
Health – life expectancy	Political rights	Primary products (% exports – negative)	Inflation (negative)
	Religious dummies (Confucian, Jewish, Protestant)		Ethnic diversity (negative)
	Openness Degree of capitalism		Civil liberties Revolutions, coups, wars (negative)
			Religious dummies (Buddhism, Catholic)
			Public investment

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Does Aid Work?



Does Aid Work?



Does Aid Work?

The empirical evidence suggests that aid has no significant effect on economic development!

Hypothesis Tested	Number of Studies evaluated	Consensus of Results
Does aid increase Saving and Investment?	43	75% of aid is crowded out by lower saving.
Does aid increase Growth?	103	No significant effect
Is aid effective in moderation but harmful in excess?	22	No evidence
Is aid more effective when policy is good?	28	No evidence
Is aid effective when local institutions are strong?	10	Some evidence but too few studies

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- **TFP** as the most importance source of long-run growth
 - ★ Direct- and indirect- effect on income
- **Human capital** and its role in explaining growth differentials and investment flows
- **Proximate-** vs. **fundamental** causes of growth
- **Sources of prosperity:** luck, geography, culture & institutions
- The **resource curse**
- **Institutions'** definition and elements in the definition
- **Technological progress**
- **Exogenous-** vs. **endogenous** growth models
 - ★ The **AK model** and an **extended model with human capital**

Recap! (cont.)

- **Porverty traps** as “low”-level equilibria
- **Convergence** in neoclassical- vs. endogenous- growth models
- Types of convergence:
 - ★ **Absolute** convergence
 - ★ **Conditional** convergence
- **Determinants** of the steady-state
- The role of **aid** in fostering economic development

Thank you for your attention!