ECON 4311 – Economy of Latin America

Lecture 2A: Economic Growth and Latin America (pt. 1)

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Outline

Introduction

- Today we start the study of Economic Growth.
- Not only a big block in this course. . .
- . . . but, more importantly, a fundamental part of economics.
- Listen to Robert Lucas Jr.:

"Is there some action a government of India could take that would lead the Indian economy to grow like Indonesia's or Egypt's? If so, *what* exactly? If not, what is it about the 'nature of India' that makes it so? The consequences for human welfare involved in questions like these are simply staggering: once one starts to think about them, it is impossible to think about anything else"

Introduction

Before we can get in depth into the study of economic growth (with especial emphasis in Latin America), we must understand some basics:

1. Which economic variables are best to make cross-country income comparisons? Why?

2. Any caveats with these variables that we should be aware of?

3. Why is economic growth so important?

4. Are there any empirical regularities we should be aware of?

How to Make Cross-Country Income Comparisons?

- Economists use **GDP per capita in PPPs for the same year** to make cross-country income comparisons at specific points in time.
  - Why GDP per capita? It highly correlates with measures of economic development (e.g., life expectancy, HDI, quality of life, . . .)
  - Why PPPs (purchasing power parities)? Currency conversion that eliminates differences in price levels between countries and thus equalizes purchasing powers across countries.
- Economists use **growth rates in GDP or GDP per capita in PPPs** to make cross-country comparisons in terms of growth potential.
  - Slightly larger growth rates can have tremendous welfare implications.
  - Why? The power of compounding! (Back to Bob Lucas!)

Is GDP a Perfect Measure to Make Country Comparisons?

- As any other measure, **GDP has drawbacks:**
  - It does not measure non-market activity.
    - E.g., illegal activities, home production...
  - It counts "goods" and "bads".
    - When Hurricane Maria destroyed Puerto Rico in September of 2017, resources invested in rebuilding counted as GDP.
  - Does not capture many important things.
    - Consider two countries with same GDPs but different hours worked per capita, pollution levels, different underlying income distributions,...
- A more fundamental & somewhat philosophical question: **Does GDP really measure what we ultimately care about (i.e., welfare)?**
  - Well-being/happiness vs. income?
- Despite not being a perfect measure, GDP highly correlates with many measures we associate with welfare and is easy to quantify.

What Could Go Wrong If We Don't Use PPPs?

- Suppose we adjust GDP per capita for cross-country comparisons using market exchange rates (MERs) rather than PPPs for 2017.
- Consider the following exchange rates:
  - USD/SEK= 9.1, April 2017 vs. USD/SEK= 7.9, September 2017
  - EUR/GBP= 0.8, April 2017 vs. EUR/GBP= 0.93, August 2017
- If we want to compare GDP per capita between the US and Sweden, which exchange rate is the "right" one to take?
  - Taking different exchange rates and same GDPs in domestic currencies $\Longrightarrow$ the US is 16% richer than Sweden in September than in April.
- While PPPs capture differences in costs of a given bundle of goods and services in different countries, MERs balance demand and supply for international currencies and, as such, can be extremely volatile.

Cross-Country Income Differences

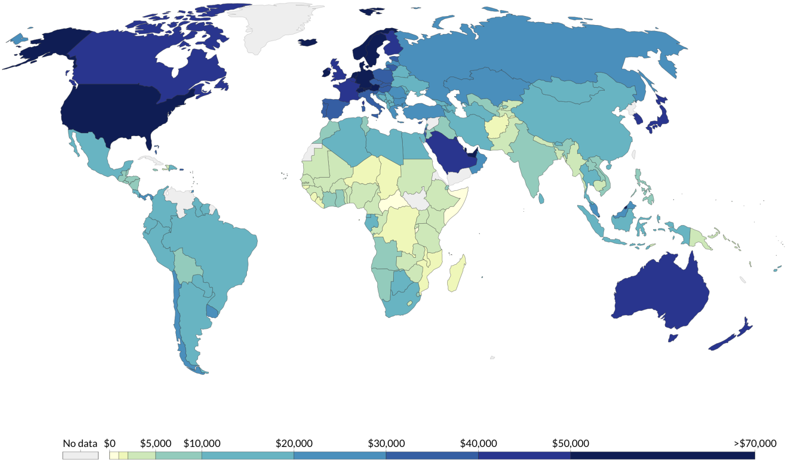


Figure: GDP per capita in 2020 (in 2020 PPPs and international dollars).
Data: World Bank.

Why is Economic Growth So Important?

Small differences in growth rates can have tremendous welfare implications over the medium/long-run.

- Consider two countries with similar GDP per capita in PPPs and international dollars in 2021:
  - Costa Rica: 20,666
  - Mexico: 20,226
- Suppose Costa Rica and Mexico grow, on average, at 1.8% and 1.5%, respectively, for the next 100 years.
- Can you guess how much richer Costa Rica would be in comparison to Mexico in 10 years? And in 25, 50, 100?
  - 5.23%, 10%, 18.5%, and 37.25%, respectively.

Our Thought Experiment

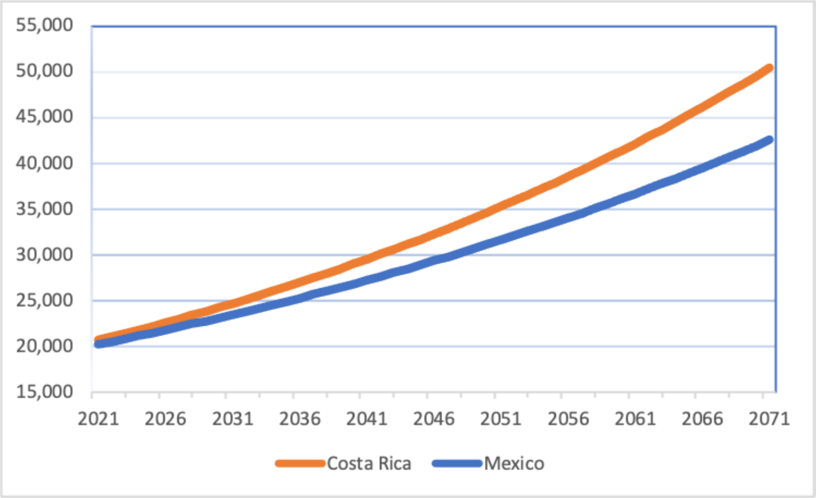


Figure: GDP per capita in PPPs and int. dollars of 2021 (y-axis), by year (x-axis)

Is There a Better Way To Look at the Data?

- Now that we understand how important economic growth is for welfare, I would like to ask you:

  Is there a better way to look at the data when comparing growth trajectories?

- **Yes!** Economists usually look at growth trajectories **using logs**.
  - When Y_t grows at a proportional rate, $\log Y_t$ grows linearly.
  - If Y_t and Z_t both grow at $x\%$, $Y_t - Z_t$ will also grow if $Y_0 \neq Z_0$, while $\log Y_t - \log Z_t$ will remain constant.

Logs: Linear vs. Exponential Growth

When Y_t grows at a proportional rate, $\log Y_t$ grows linearly.

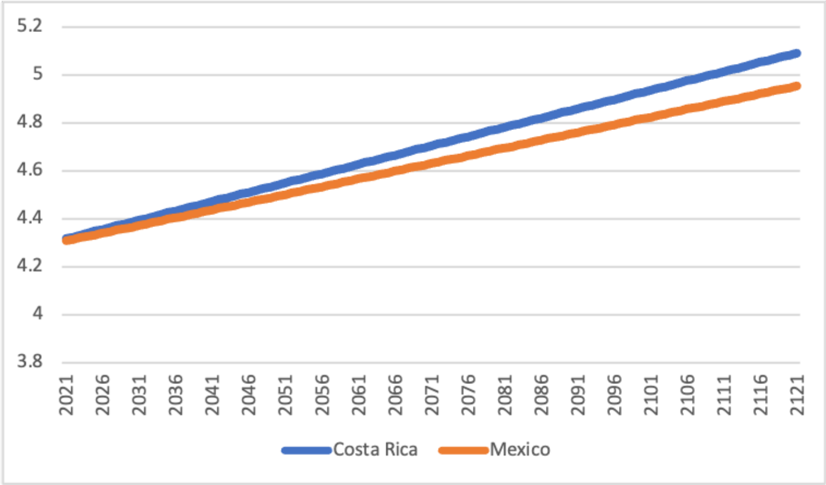
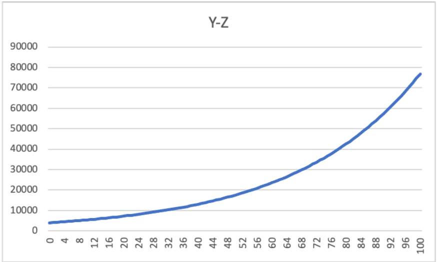
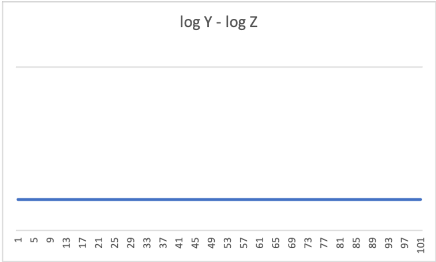


Figure: log GDP per capita in PPPs and int. dollars of 2021 (y-axis), by year.

Logs: Do Differences Come from Growth Rates or Levels?

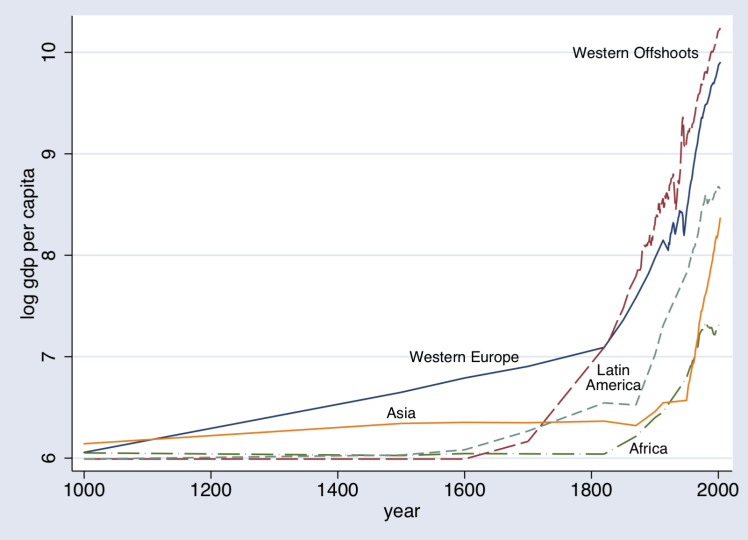
- If Y_t and Z_t both grow at $x\%$, $Y_t - Z_t$ will also grow if $Y_0 \neq Z_0$, while $\log Y_t - \log Z_t$ will remain constant.
- Suppose $Y_0 = 24k$ and $Z_0 = 20k$, and that both grow at 3%.





- Left panel: Tells differences between Y and Z grow larger over time.
- Right panel: Tells Y and Z grow at the same rate.
- Left + right panel: increasing differences between Y and Z come from levels, not growth rates.

Growth Comparisons, by Region



Growth as a Modern Phenomenon

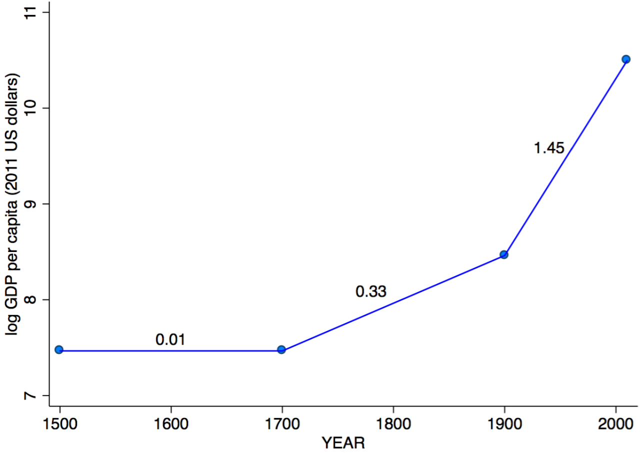


Figure: The world's GDP per capita and its growth rates, 1500–2016.

Growth as a Modern Phenomenon

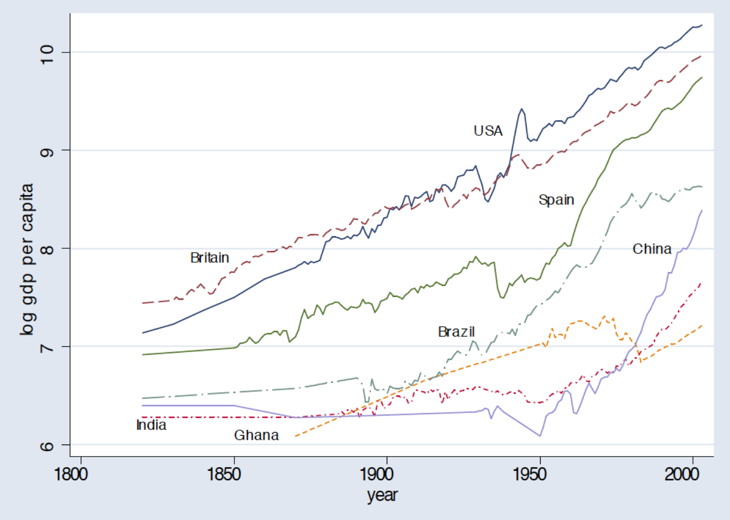


Figure: Growth over the last 200 years for selected countries

The Kaldor Facts

- The Kaldor (1961) (long-run economic growth) facts:
  1. Growth of labor productivity (Y/L) is constant over time.
  2. Growth of capital per worker (K/L) is constant over time.
  3. The real interest rate (r) is constant over time.
  4. The capital-output ratio (K/Y) is constant over time.
  5. Factor income shares ($1 - \alpha$) are constant over time.
  6. Substantial variation in growth rates (in the order of 2–5%) among the world's fastest growing countries.
- Economists believe that successful growth models must be consistent with Kaldor's facts.
  - Recently, one of these facts has been challenged. Any guess?

Constancy of per-capita growth

- A linear fit suggests that the series is well approximated by annual growth rate of 1.84% (R-squared=0.99)

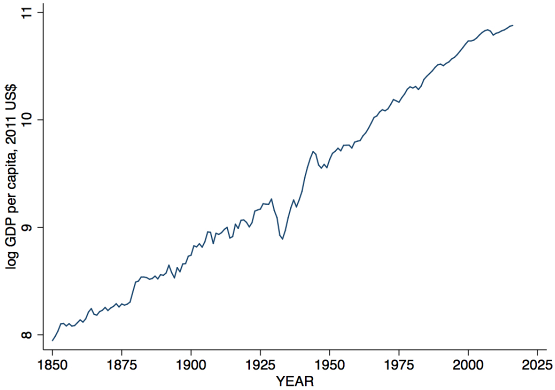


Figure: US's GDP per capita growth, 1850-2016

Constancy of capital-output ratio

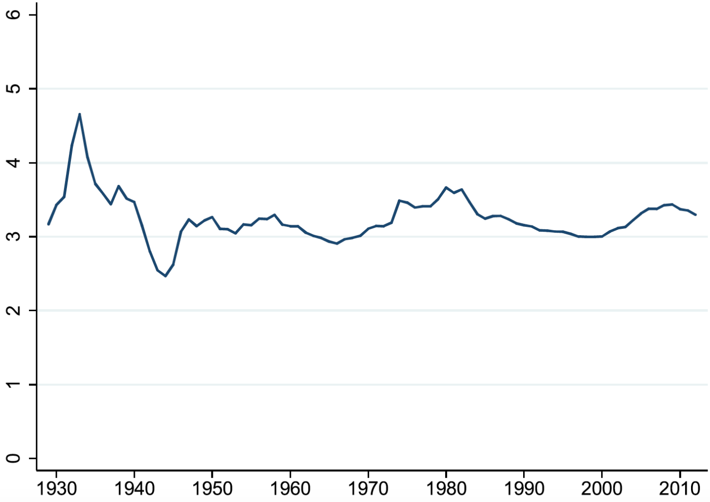


Figure: US capital-output ratio

Constancy of factor shares

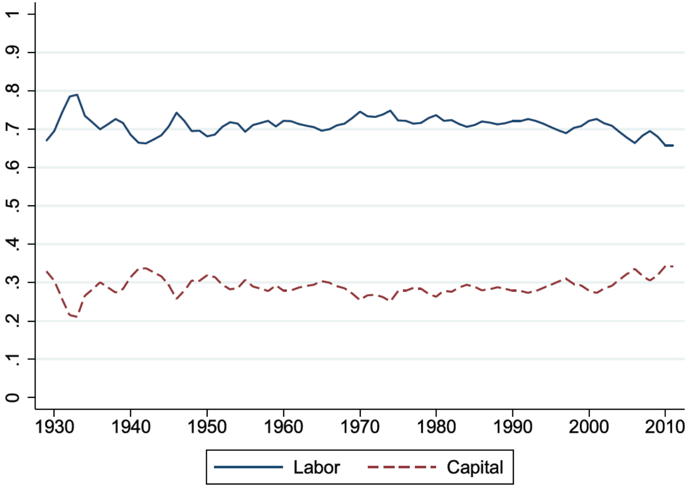


Figure: US factor shares

Properties Useful for Growth Analysis

- Define the annual growth rate of Y in any year t as the annual percentage change in Y from the previous year:

$$g_{Y,t} \equiv \hat{Y}_t = \frac{Y_t - Y_{t-1}}{Y_{t-1}}. \tag{1}$$

- Growth rates are compounding over time (starting from $t = 0$):

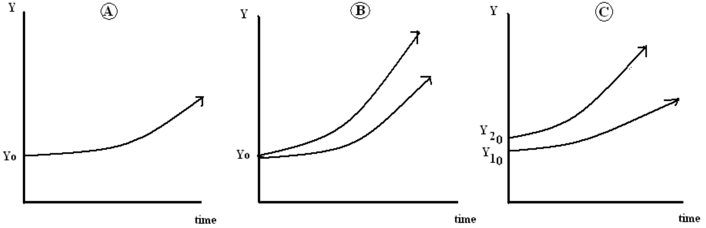
$$\begin{aligned}
Y_1 &= (1 + g_{Y,1})Y_0, \\
Y_2 &= (1 + g_{Y,2})Y_1, \\
&= (1 + g_{Y,1})(1 + g_{Y,2})Y_0, \\
&\vdots \\
Y_t &= (1 + g_{Y,1})(1 + g_{Y,2}) \cdots (1 + g_{Y,t})Y_0.
\end{aligned}$$

Properties Useful for Growth Analysis

- If growth rates turn out to be constant, the math simplifies:

$$\begin{aligned} Y_1 &= (1+g_Y)Y_0, \\ Y_2 &= (1+g_Y)Y_1, \\ &= (1+g_Y)(1+g_Y)Y_0, \\ &= (1+g_Y)^2 Y_0, \\ &\vdots \\ Y_t &= (1+g_Y)^t Y_0. \end{aligned} \tag{2}$$

Properties Useful for Growth Analysis



- Graphically:
  A. $Y_t = (1 + g_Y)^t Y_0$ for $g_Y > 0$.
  (Our thought experiment, in levels, for a given country)
  B. $Y_t = (1 + g_Y)^t Y_0$ vs. $Y_t = (1 + \tilde{g}_Y)^t Y_0$, where $g_Y > \tilde{g}_Y > 0$.
  (Our thought experiment, in levels)
  C. $Y_{1,t} = (1 + g_Y)^t Y_{1,0}$ vs. $Y_{2,t} = (1 + g_Y)^t Y_{2,0}$ for $g_Y > 0$.
  (What we would see if we plotted the Y_t vs. Z_t of slide 12)

Properties Useful for Growth Analysis

- How to calculate the average annual growth for a given country c between 2000 and 2020:

$$Y^c_{2020} = (1 + g_Y)^{20} Y^c_{2000} \qquad \Longrightarrow \qquad g_Y = \left(\frac{Y^c_{2020}}{Y^c_{2000}} \right)^{\frac{1}{20}} - 1$$

- If we do this calculation with real data for, say, $c =$Chile, we obtain $g_Y \approx 0.0315$.

- This number should be interpreted as a 3.15% average annual growth rate for the Chilean economy during the period 2000–2020.

- A useful approximation for any small number x is:

$$\log(1 + x) \approx x. \tag{3}$$

Properties Useful for Growth Analysis

- Why do we say that $\log(1+x) \approx x$ is a useful approximation?
- Suppose we observe Y^c_{2020} and Y^c_{2000}, where c is any given country, and that we want to calculate the average annual growth rate.
- We know that
$$Y^c_{2020} = (1+g_Y)^{20} Y^c_{2000}.$$
- Taking logs:
$$\log Y^c_{2020} = 20 \log(1+g_Y) + \log Y^c_{2000}.$$
- Rearranging:
$$\log(1+g_Y) = \frac{\log Y^c_{2020} - \log Y^c_{2000}}{20}$$
- With our approximation:
$$g_Y \approx \frac{\log Y^c_{2020} - \log Y^c_{2000}}{20}.$$

Properties Useful for Growth Analysis

How long will take for a country to double its standards of living?

- Mathematically, we are asking: in what year t will GDP per capita for country c be twice that of year 0, where year 0 is the base year?
- To find the answer we can again exploit the relationship between Y_t, Y_0, and a "predicted" constant growth rate g_Y.
- We want to solve:

$$Y_t^c = 2Y_0^c.$$

- Substituting for Y_t^c:

$$(1+g_Y)^t Y_0^c = 2Y_0^c \quad \iff \quad (1+g_Y)^t = 2.$$

- Taking logs and solving for t:

$$t = \frac{\log 2}{\log(1+g_Y)} \approx \frac{0.7}{g_Y}.$$

Properties Useful for Growth Analysis

How long will take for a country to double its standards of living?

$$t = \frac{\log 2}{\log(1 + g_Y)} \approx \frac{0.7}{g_Y}. \quad (4)$$

- Let's put the math into practice.
- How long will it take for standards of living to double in Puerto Rico if it were to grow at an annual constant rate of:
  - 1%? 70 years
  - 2%? 35 years
  - 3%? 23.233 years
  - 5%? 14 years
- What's the difference in years that it takes to double GDP per capita for two countries with annual growth rates of 1% and 1.1%, respect.?

Growth Accounting Through the Lens of the Solow Model

- Solow-Swan model, most often referred to as **Solow Growth Model** (Solow, 1956; Swan, 1956) was a game changer!

- A simple framework to think about the *proximate causes* of economic growth, (technology, capital, labor input), and how these drive cross-country income differences.

- At the center of the Solow model is the *neoclassical* (aggregate) production function, typically parametrized as:

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha},$$

where Y denotes output, A technological progress, K physical capital, L hours worked, and $\alpha \in (0,1)$ is the share of capital in GDP.

Growth Accounting Through the Lens of the Solow Model

- Multiple ways to look at the data through the Solow Model:
  1. Growth accounting exercises: Solow's (1957) contribution
  2. Regression-based approaches
  3. Calibration exercises
- Solow's (1957) growth accounting exercise starts with

$$Y(t) = A(t)K(t)^{\alpha}L(t)^{1-\alpha}$$

- Notice the difference in notation between:

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha}, \quad \text{(discrete time)}$$
$$Y(t) = A(t)K(t)^{\alpha}L(t)^{1-\alpha}. \quad \text{(continuous time)}$$

- Sometimes it is more convenient to work in continuous time.

Growth Accounting Through the Lens of the Solow Model

- Consider

$$Y(t) = A(t)K(t)^{\alpha}L(t)^{1-\alpha}.$$

- Take logs:

$$\log Y(t) = \log A(t) + \alpha \log K(t) + (1-\alpha)\log L(t).$$

- Differentiate both sides with respect to time:

$$\frac{d \log Y(t)}{d\ t} = \frac{d \log A(t)}{d\ t} + \alpha \frac{d \log K(t)}{d\ t} + (1-\alpha)\frac{d \log L(t)}{d\ t}$$
$$\iff \quad g_Y(t) = g_A(t) + \alpha g_K(t) + (1-\alpha) g_L(t). \tag{5}$$

(In continuous time, time derivatives of logs are equal to growth rates)

Missing steps

Growth Accounting Through the Lens of the Solow Model

- Solow's accounting exercise revealed that technology could explain a large part of the growth process.

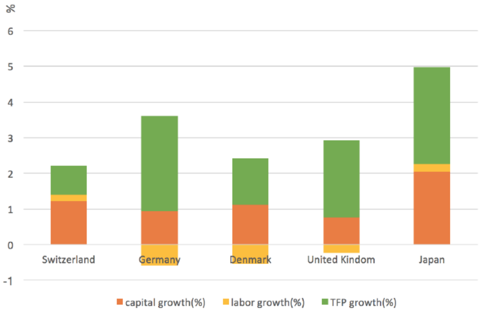


Figure: Growth accounting, 1970–1990 (Wang et al., 2017)

- In your next assignment, you will have to verify whether this holds true for particular Latin American countries.

Taking Stock

- Hopefully, now you are as fascinated about economic growth as I first was when I encountered this topic!
- I also hope you now understand better some things:
  - How to make cross-country income comparisons.
  - Why GDP, although not perfect, is a good metric to measure growth.
  - The welfare implications of designing econ policies that foster growth.
  - The relative position of a country in the world income distribution can change relatively quickly.
  - The properties of logs and how useful these are.
- . . . and have learnt some new stuff:
  - The Kaldor facts.
  - How to do growth accounting.

What's Coming Next

- Talk about institutions and look at LatAm data in this respect.
  - Assess the impact of colonization policies in long-run growth.
- Dig a big deeper into growth:
  - Proximate vs. fundamental causes of growth.
  - Understand more mechanically the process of growth.
- Think about the impact of structural reforms on growth trajectories.
  - Discuss some particular examples in LatAm countries.
- Talk about the relationship between growth and the environment.

Thank You!

Extra Slides

Missing Steps

- Notice that

$$\frac{d\log Y(t)}{dt} = \frac{d\log Y(t)}{d\ Y(t)}\frac{dY(t)}{dt} = \frac{1}{Y(t)}\dot{Y}(t) = g_Y(t).$$

- Hence,

$$\frac{d\log Y(t)}{d\ t} = \frac{d\log A(t)}{d\ t} + \alpha\frac{d\log K(t)}{d\ t} + (1-\alpha)\frac{d\log L(t)}{d\ t}$$
$$\iff \quad g_Y(t) = g_A(t) + \alpha g_K(t) + (1-\alpha)g_L(t).$$

Back