Introduction to Economic Growth: Why some countries are poorer than others?

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Lecture 1: Facts and mysteries of Growth

The world we live in...

- If I were to ask you for ***Two Words*** to describe the socio-economic reality of our world... What would your words be?

The world we live in...

- If I were to ask you for ***Two Words*** to describe the socio-economic reality of our world... What would your words be?
- Mine are: (i) Inequality and (ii) Growth

Global Poverty

1. Global poverty lines are used to measure the financial dimension of poverty. The thresholds of $1.90, $3.20, and $5.50 per day represent different standards for poverty around the world. People living on $1.90 per day are considered to live in extreme poverty.[1]
2. Money isn't a complete measure of poverty. Other dimensions of poverty include access (or lack thereof) to work, health, nutrition, education, sanitation, housing, etc.[2]
3. In 2015 (the latest estimates available), 10% of the world's population lived in extreme poverty (less than $1.90 a day).[3]
4. Half of the 736 million people living in extreme poverty globally live in five countries: India, Nigeria, Democratic Republic of Congo, Ethiopia, and Bangladesh.[4]
5. It's estimated that, because of the COVID-19 pandemic and subsequent global recession, poverty rates will increase for the first time since 1990. [5]
6. Internationally, 2.2 million people lack access to a safely-managed drinking water service (located nearby, available when needed, and free from contamination).[6]
7. Approximately 297,000 children under five die every year from diarrhoeal diseases due to poor sanitation, poor hygiene, or unsafe drinking water.[7]
8. About 13% of people globally do not have access to electricity, and 40% of people globally do not have access to clean fuels for cooking.[8]
9. Malnutrition is the leading cause of poor health and death around the world. Globally, 1 in 9 people is hungry or undernourished.[9]
10. A study of 13 developing countries found that government spending on education and health accounted for 69% of the total reduction of economic inequality.[10]
11. The entire health budget of Ethiopia, a country of 105 million people, is equivalent to just 1% of the fortune of the world's richest man, Amazon CEO Jeff Bezos.[11]

Figure 1: Global poverty in numbers. Source: dosomething.org

Family Portraits: USA

Figure 2: A typical family in Texas, USA. Source: Material World Project by Peter Menzel.

Family Portraits: Mexico

Figure 3: A typical family in Guadalajara, Mexico. Source: Material World Project by Peter Menzel.

Family Portraits: Mali

Figure 4: A typical family in Kouakourou, Mali. Source: Material World Project by Peter Menzel.

There is also a massive change (growth) in the standards of living

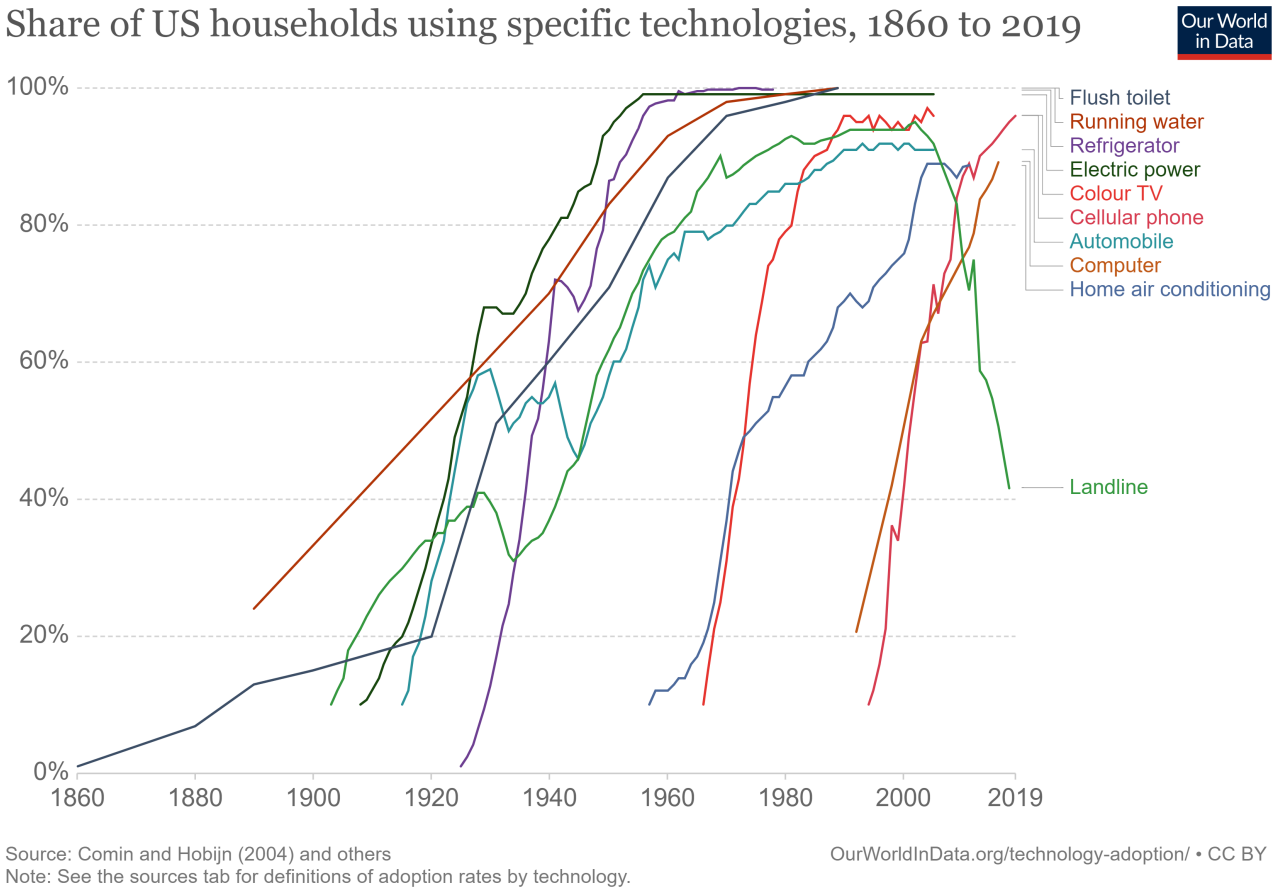


Figure 5: Technological adoption in the US over the last 160 years. Source: ourworldindata.org

Today's lecture

1. Some facts and questions
2. Measuring Growth and Prosperity
3. Conceptual Framework
4. Mathematical appendices
   - Natural Logarithms
   - Logarithms and Growth Rates

Table of Contents

Inequality across the world today

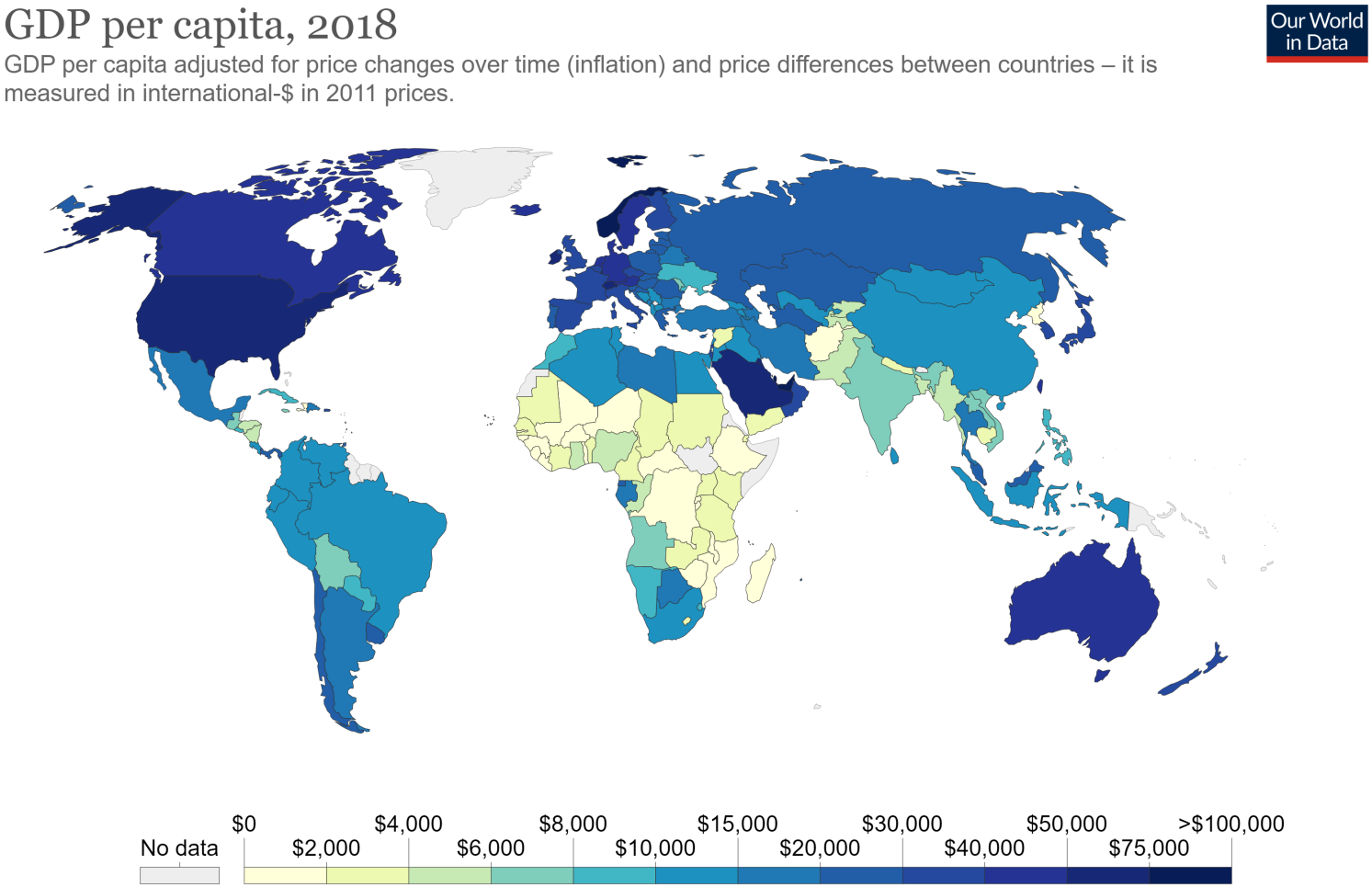


Figure 6: GDP per capita across the world in 2018. Source: ourworldindata.org

Inequality across the world today: the richest, the middle, and the poorest

World Bank (2019)[6]

Rank	Country/Territory	Int$
—	*Macau*	129,451
1	Luxembourg	124,591
2	Singapore	101,649
3	Qatar	94,029
4	Ireland	89,684
—	*Bermuda*	85,418
—	*Cayman Islands* (2018)	73,292
5	Switzerland	72,376
6	United Arab Emirates	70,089
7	Norway	70,006
8	United States	65,298
9	Brunei	64,848
—	*Hong Kong*	62,496
11	Denmark	62,090
13	Netherlands	61,285
67	Serbia	19,495
68	Equatorial Guinea	19,379
69	Thailand	19,277
70	Dominican Republic	19,228
71	Botswana	18,553
72	Palau	18,357
73	North Macedonia	18,108
—	*World*	17,811
74	Grenada	17,793
75	Venezuela (2011)	17,527
76	Suriname	17,256
77	China	16,804
78	Barbados	16,331
79	Bosnia and Herzegovina	16,289
80	Saint Lucia	16,132
81	Colombia	16,012
82	Libya	15,846
171	Burkina Faso	2,275
172	Afghanistan	2,156
173	Guinea-Bissau	2,077
174	Sierra Leone	1,794
175	Madagascar	1,720
176	Togo	1,667
177	Chad	1,650
178	Eritrea (2011)	1,626
179	Liberia	1,491
180	Mozambique	1,338
181	Niger	1,279
182	South Sudan (2015)	1,235
183	Democratic Republic of the Congo	1,147
184	Malawi	1,107
185	Central African Republic	987
186	Burundi	785

Figure 7: GDP per capita in the richest, the average, and the poorest individual countries in 2019 (the WB estimate). Source: wikipedia.org

Inequality across the world historically: divergence

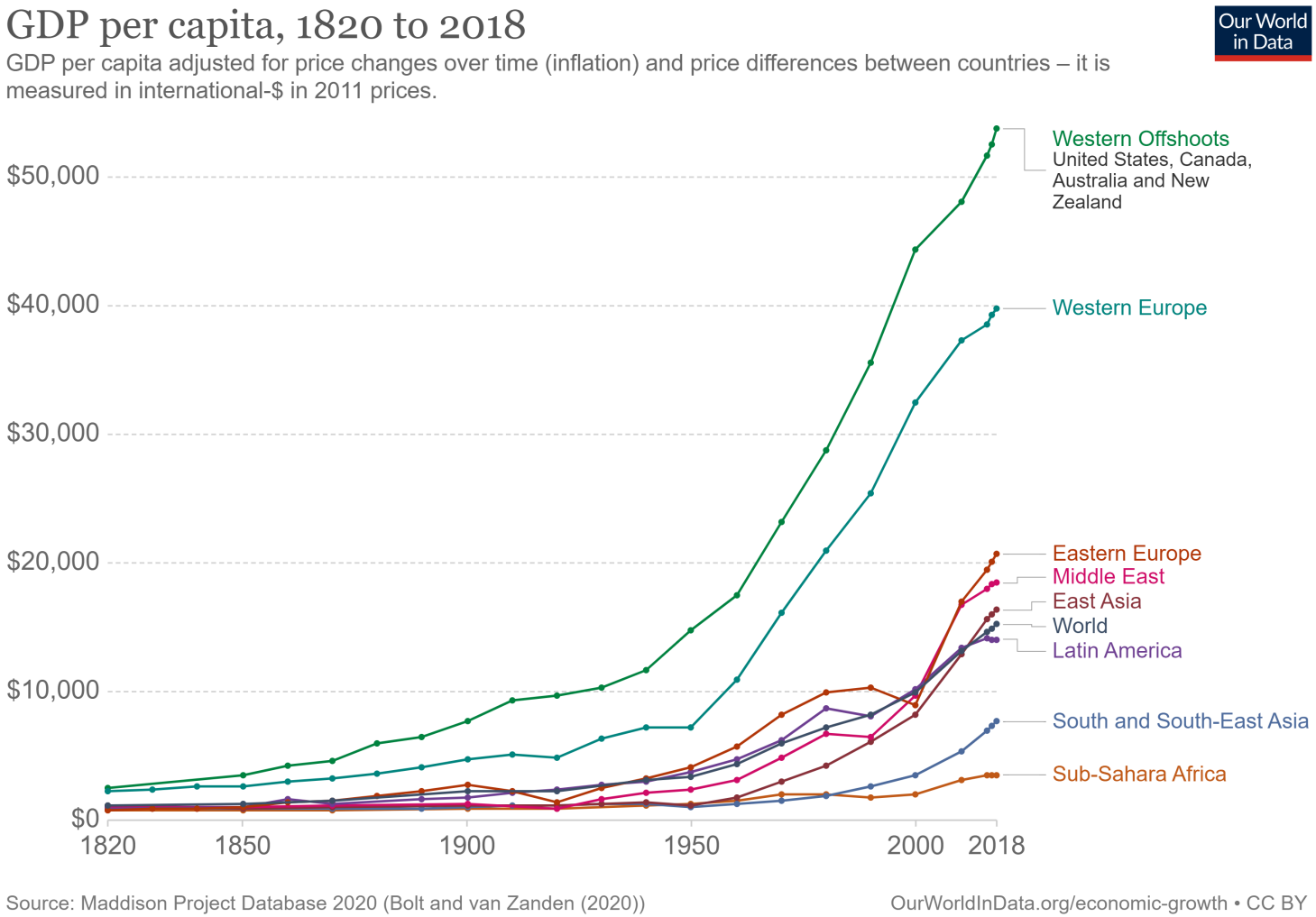


Figure 8: Divergence of incomes per capita. Source: ourworldindata.org

Inequality across the world historically: long period of stagnation

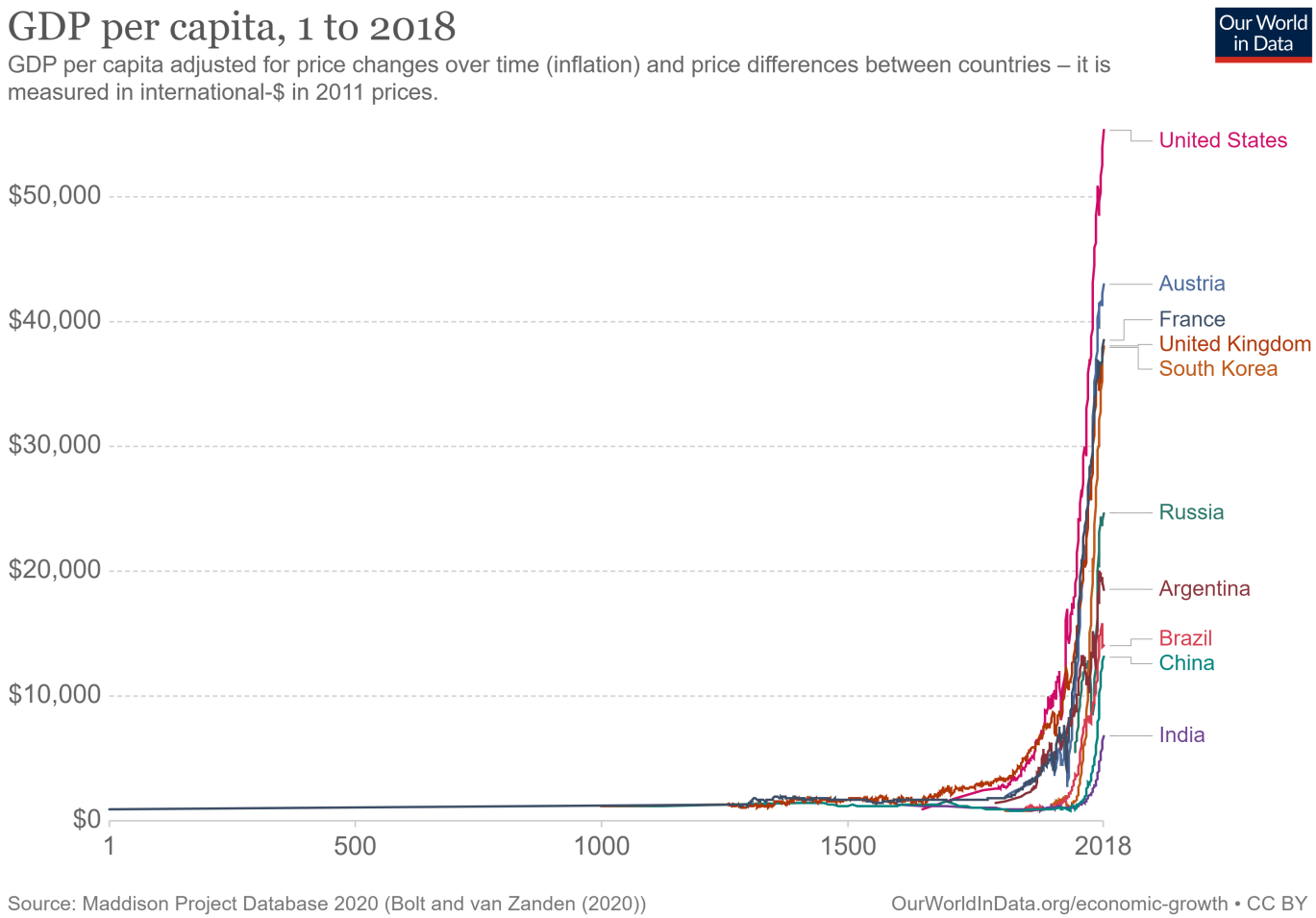


Figure 9: Divergence of incomes per capita. Source: ourworldindata.org

Population growth historically - same dynamics as for income per capita?

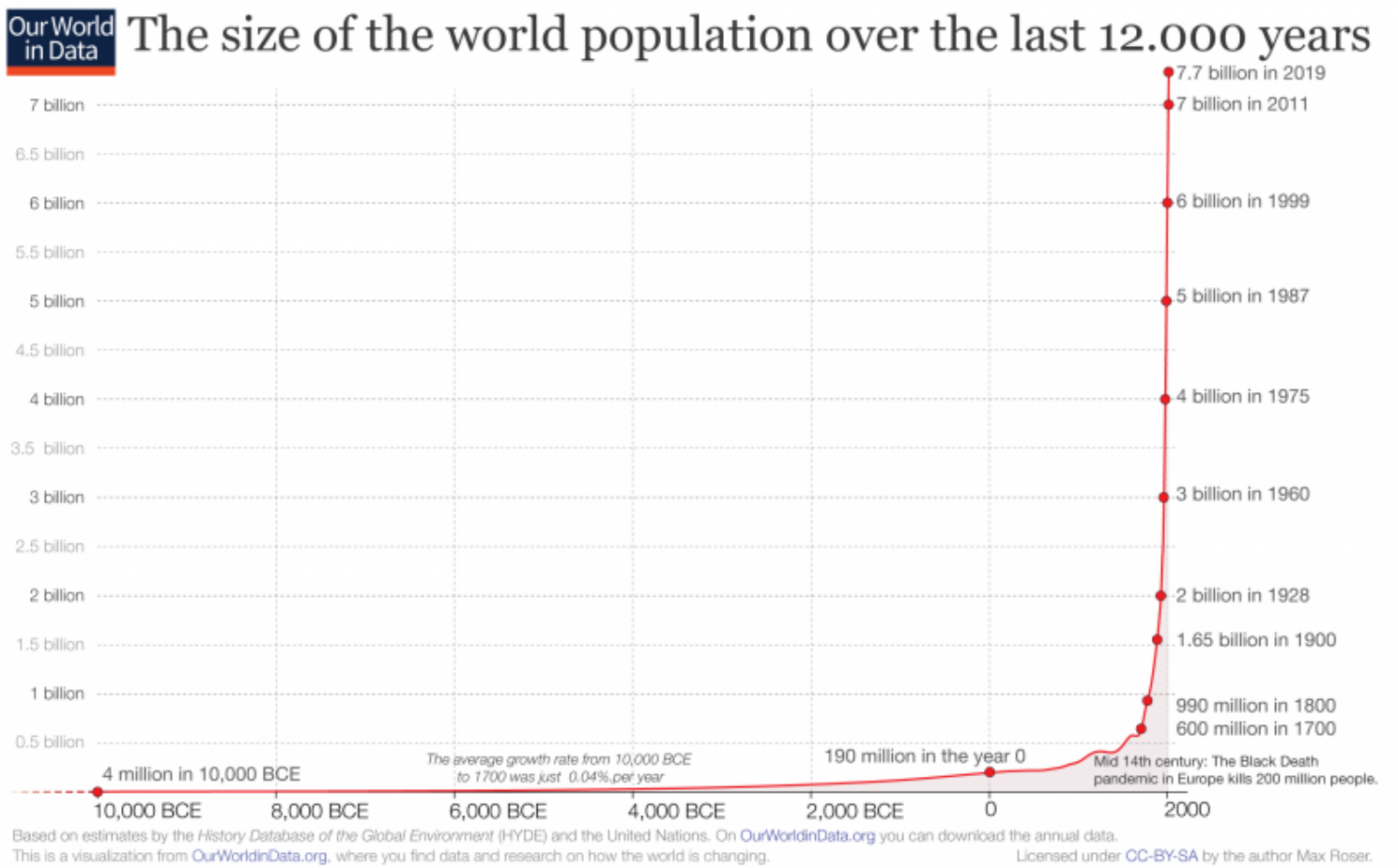


Figure 10: World population since 10000BC. Source: ourworldindata.org

But today: richer countries give fewer births?

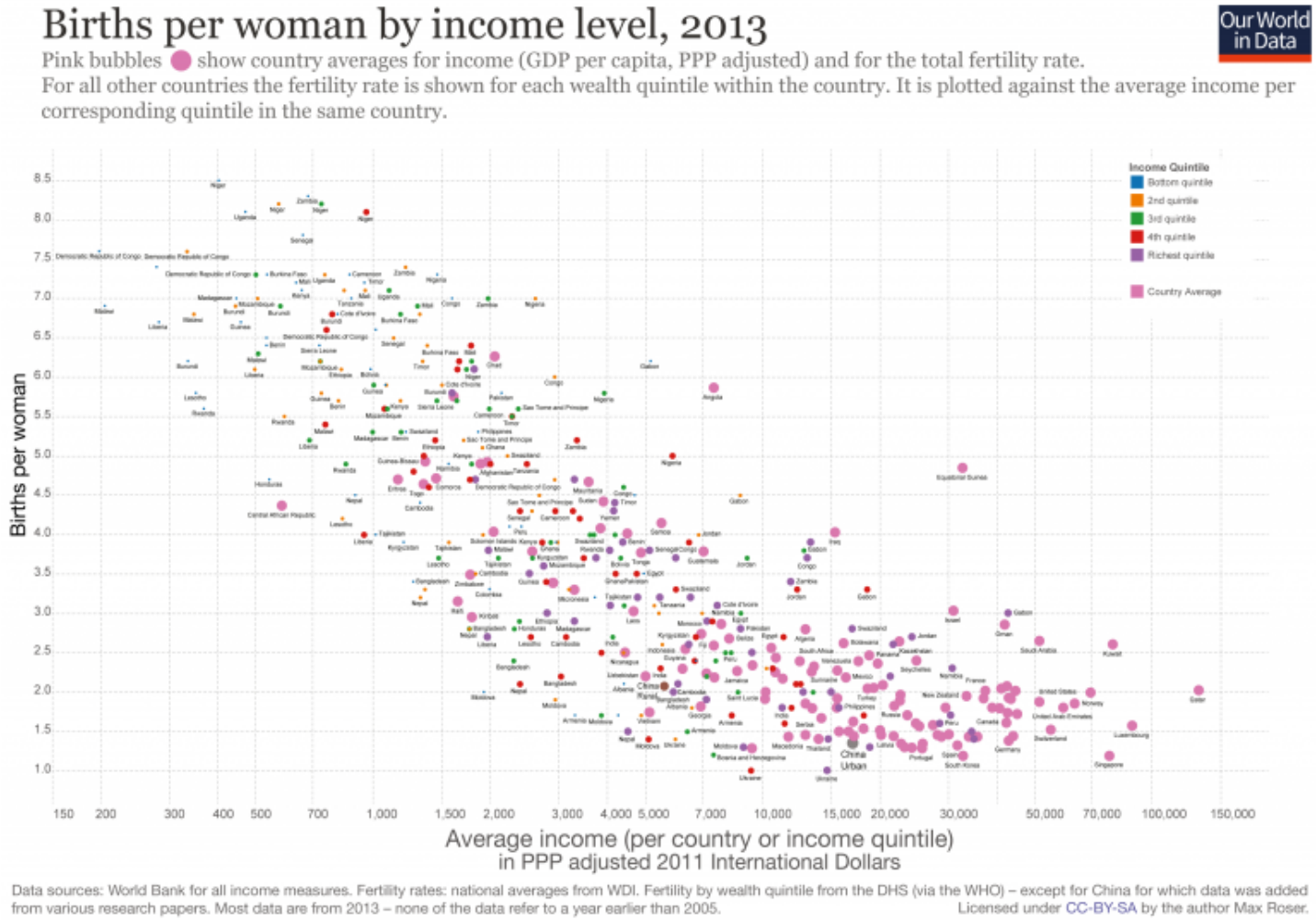


Figure 11: World population since 10000BC. Source: ourworldindata.org

Richer countries invest more?

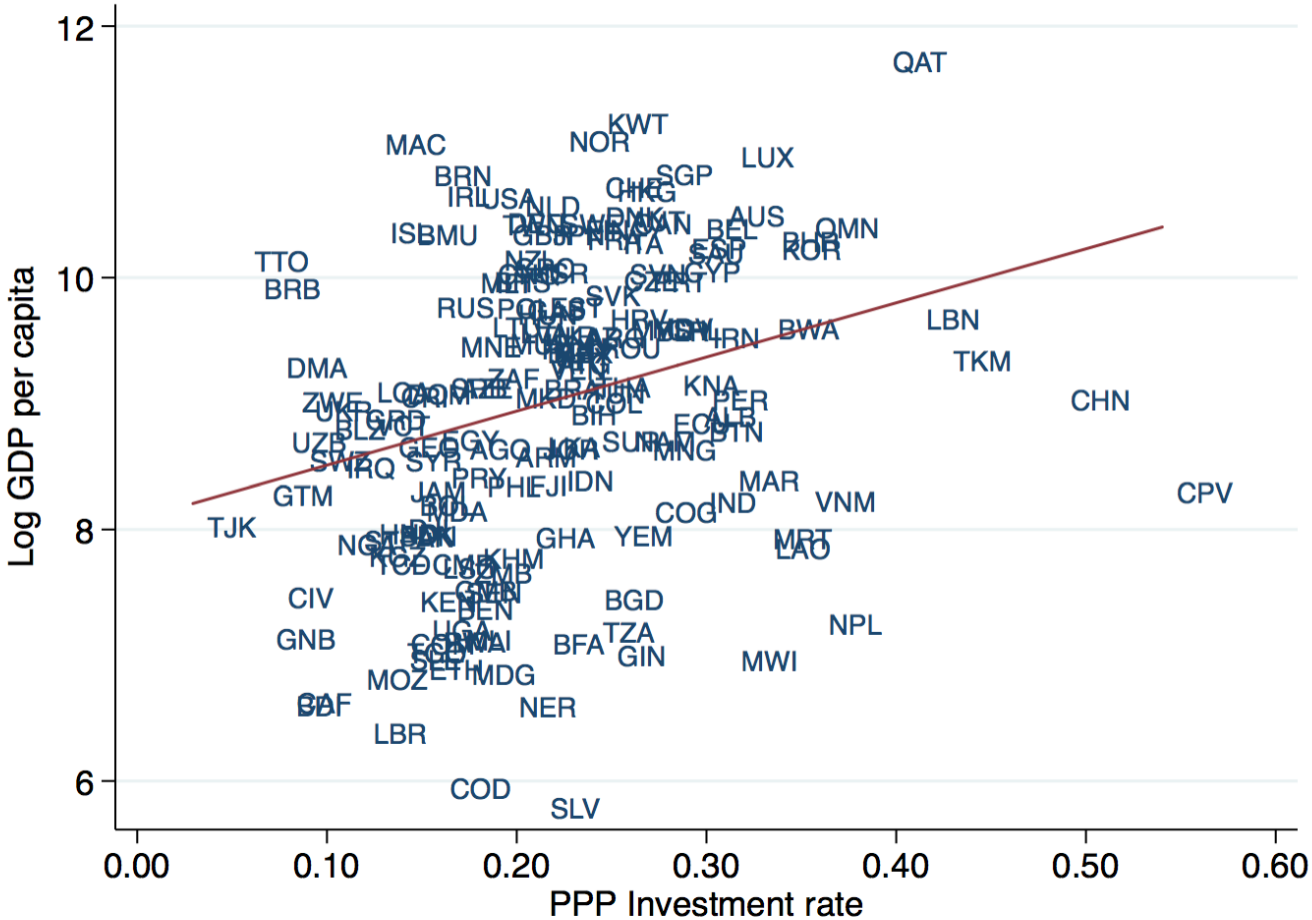


Figure 12: Investment share in GDP and per capita incomes across the world. Source: growthecon.com blog by Dietrich Vollrath

Rich countries have access to better technologies? What causes what here?

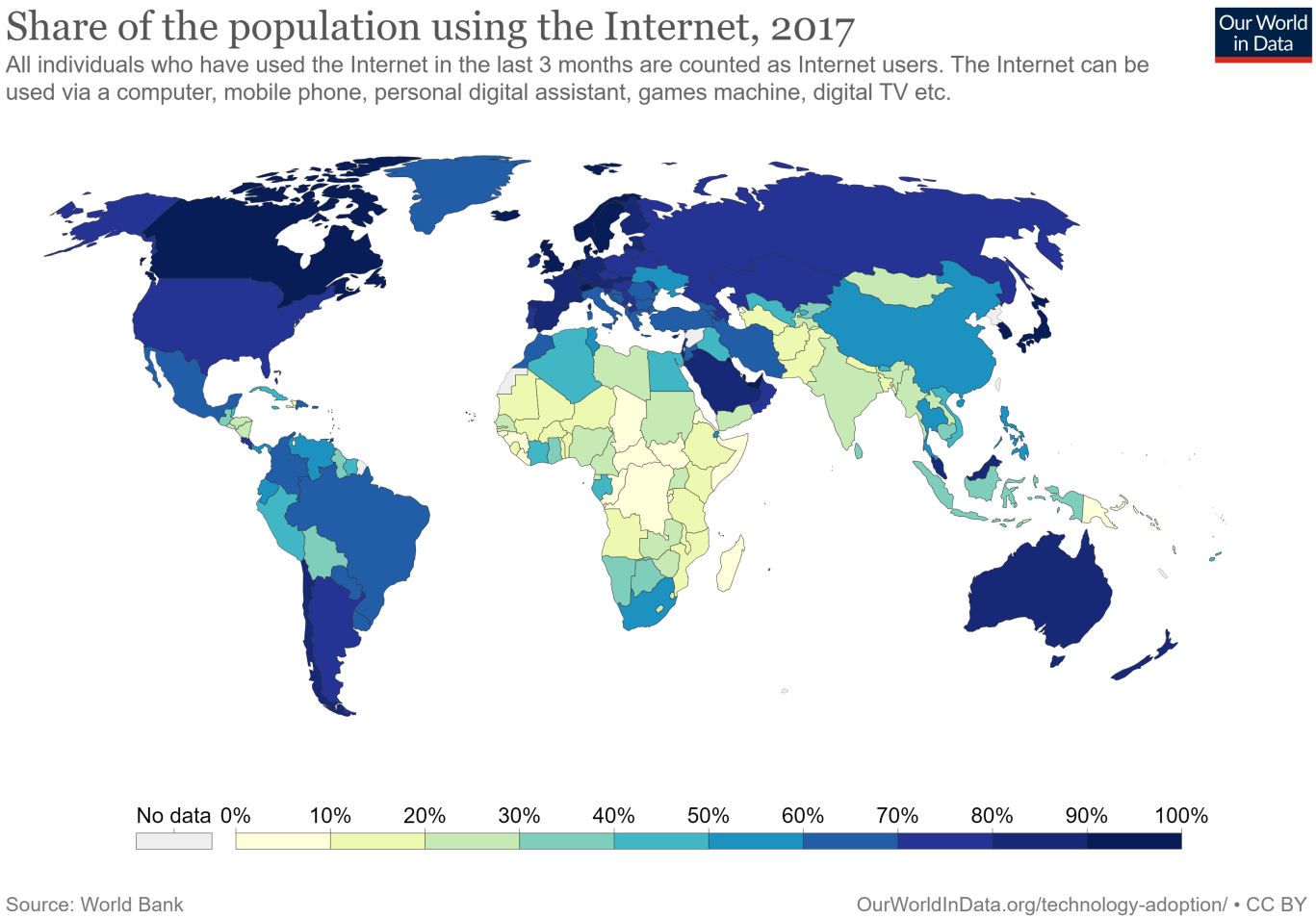


Figure 13: Share of population using the Internet. Source: ourworldindata.org

Deeper roots of prosperity: Institutions?

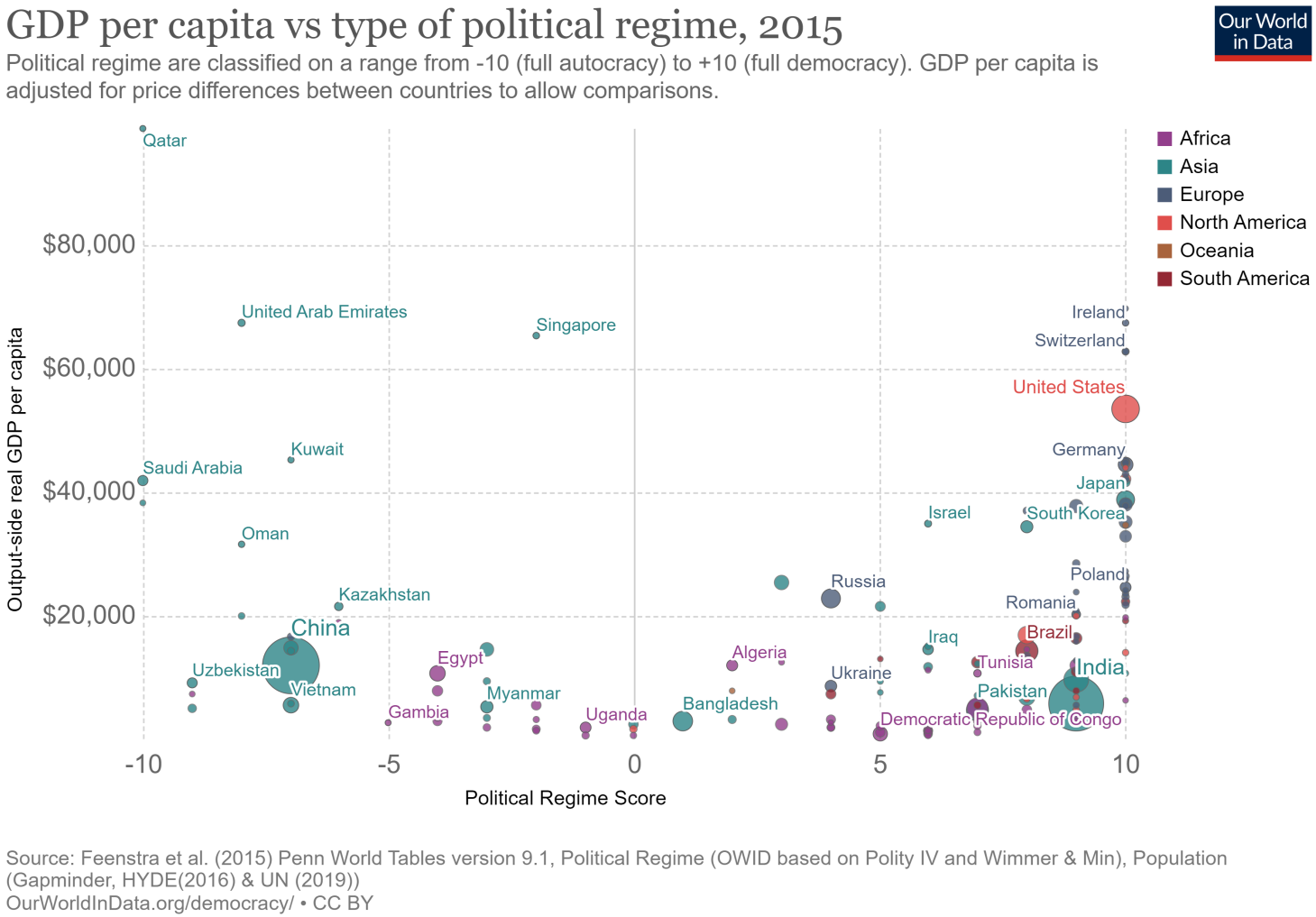


Figure 14: Political regimes and prosperity. Source: ourworldindata.org

Deeper roots of prosperity: Institutions?

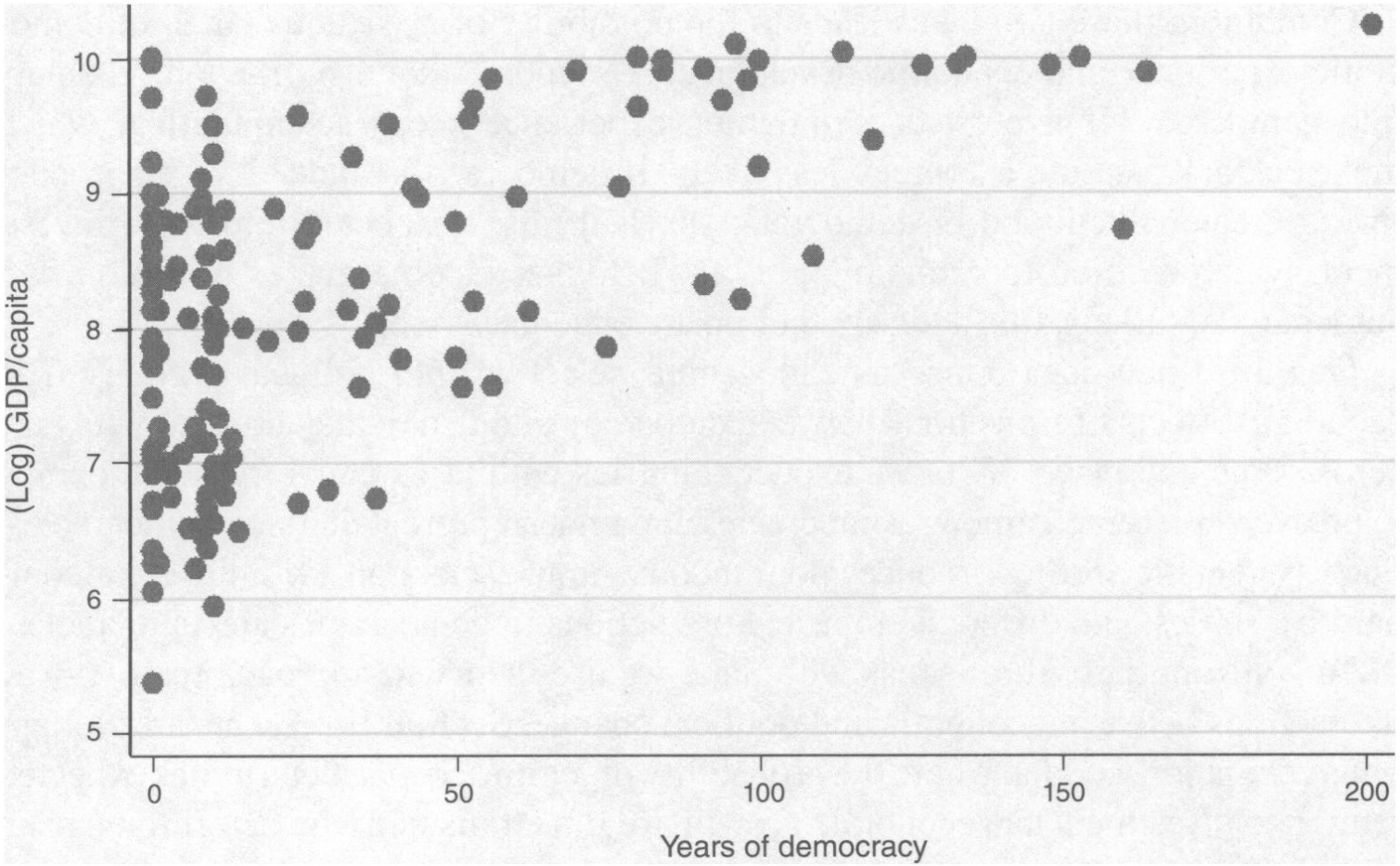


Figure 15: 'Democratic capital' and GDP per capita, Persson and Tabellini (2009)

Deep roots of prosperity: Culture?

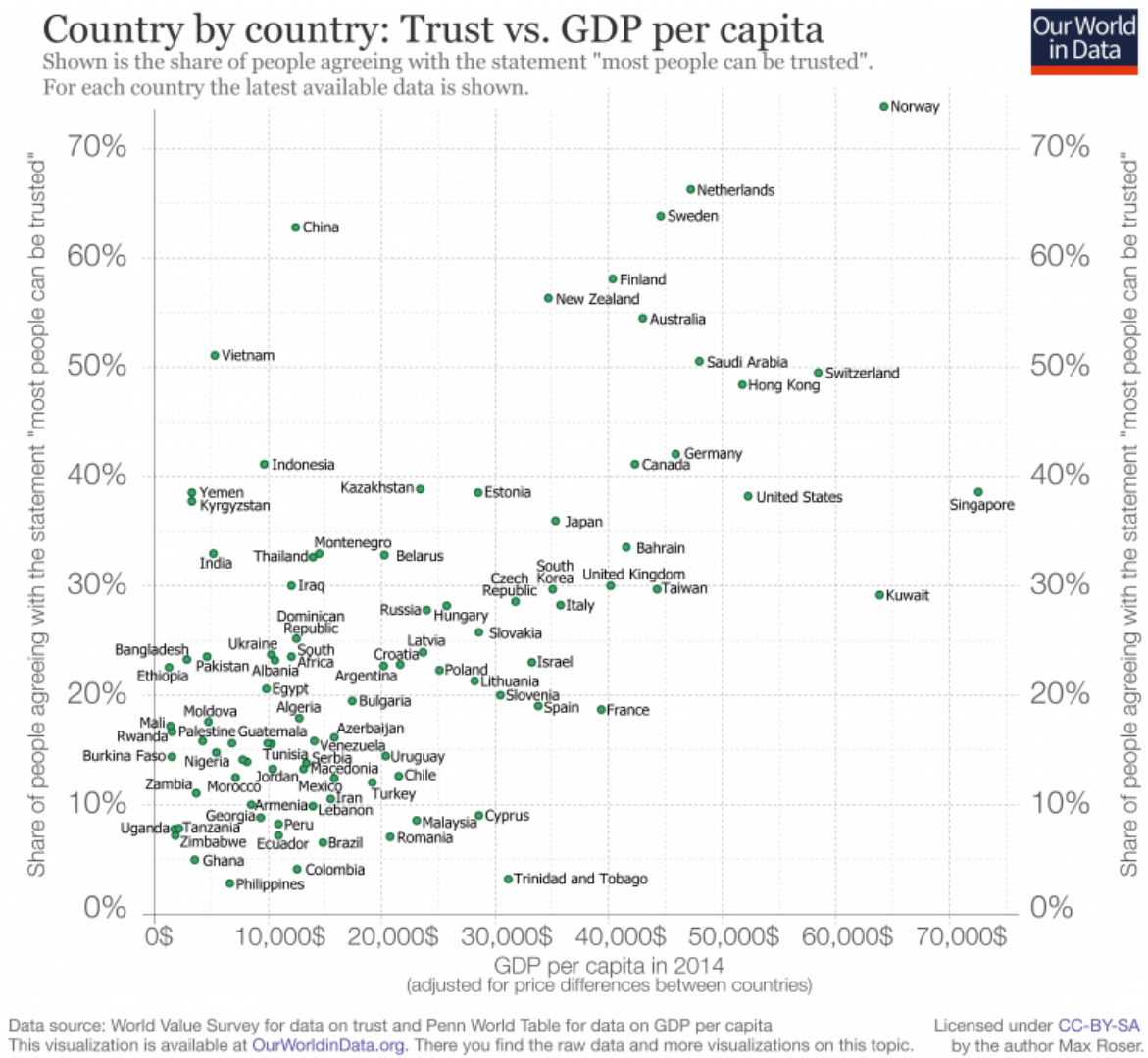


Figure 16: 'Do you think most people can be trusted?' and GDP per capita

Deep roots of prosperity: Geography?

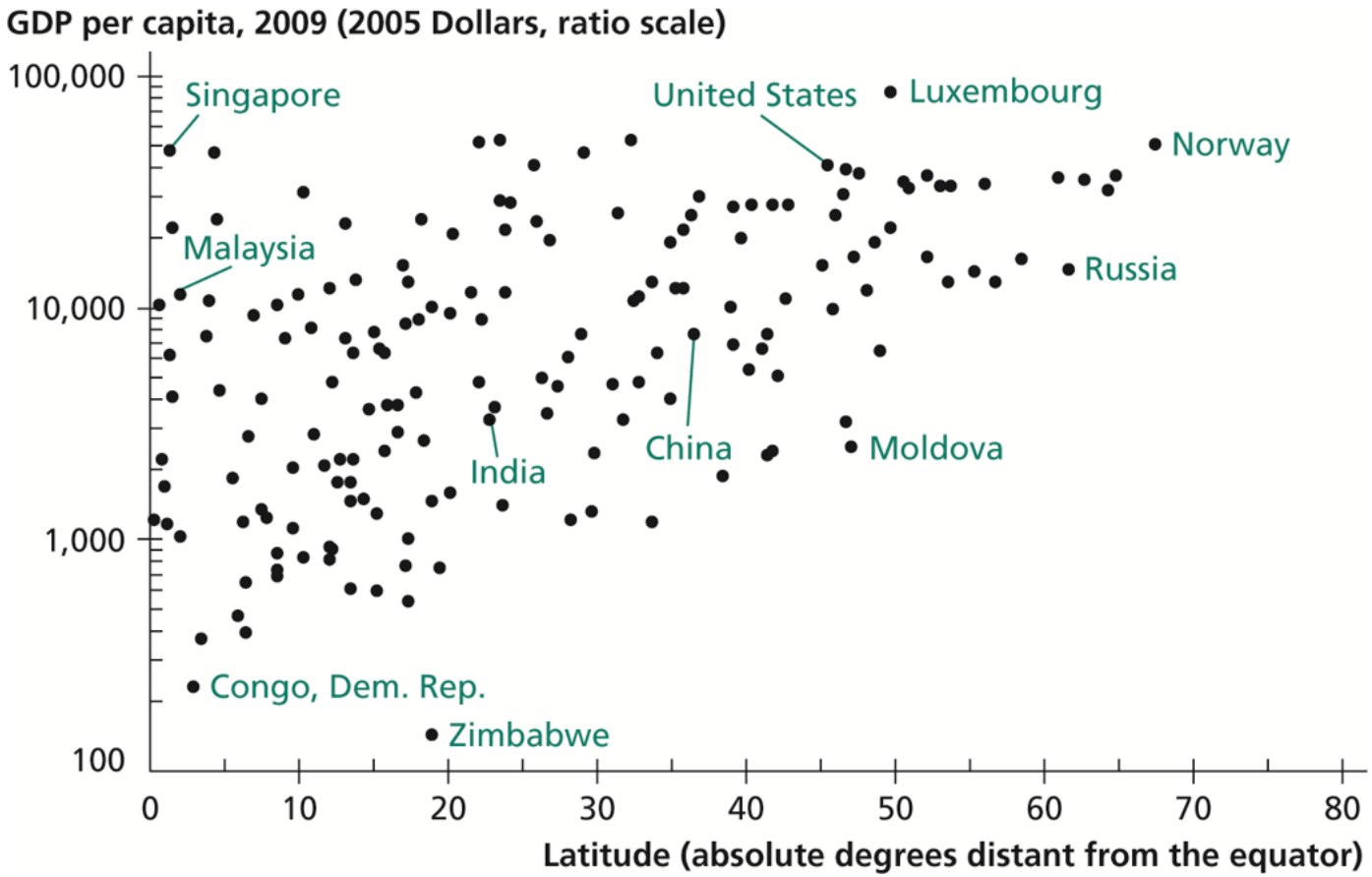


Figure 17: Absolute latitude and incomes per capita, Weil (2013)

Table of Contents

Measuring Economic Growth and Prosperity

There are two main measures of Growth and Development that we will be focusing on throughout the course:

- Gross Domestic Product (GDP) per capita, or just GDP per capita[1]
- Growth rate of GDP (and GDP per capita)

However, there are many other measures that are crucial for a broader understanding of growth and, more generally, well-being:

- Life expectancy (how long a person is expected to live, on average)
- Education (literacy rates, years of schooling, etc.)
- Human rights (freedom of speech, democratic politics, etc.)
- And so many others (continue this list yourself?)

[1] Will also see logarithm of GDP per capita; we'll talk about why it matters

Measuring Economic Growth and Prosperity

Definition (GDP per capita)

The total value of all final goods and services produced in a country in a given year, divided by this country' total population. If $\$Y$ is GDP, and L is population, then GDP per capita is $\$y = \$Y/L$.

- *Nominal* GDP (in \$) is based on the current market exchange rate.
- *Purchasing Power Parity (PPP)* GDP is based on PPP exchange rate that takes into account varying prices and costs of living across countries[2].
- *Real* GDP refers to GDP expressed in constant prices (prices of a base year) to account for inflation.

[2] For some counties, differences between the two can be huge: https://statisticstimes.com/economy/gdp-nominal-vs-gdp-ppp.php

Measuring Economic Growth and Prosperity

Definition (Growth rate of GDP per capita)

Relative change in the level of GDP per capita, computed between any two periods of time. Often, we look at yearly changes. If y_t is GDP per capita in year t, and y_{t-1} is GDP per capita in year $t-1$, then the growth rate of GDP per capita is given by $g_{y,t} = \frac{y_t - y_{t-1}}{y_{t-1}}$ (multiplied by 100% if we want percentage changes).

- Generally, the growth rate of any variable x between periods t and $t-1$ is given by $g_{x,t} = \frac{x_t - x_{t-1}}{x_{t-1}}$
- ***Natural logarithms***: if x grows at a constant rate g, then the dynamics of x is exponential, but the $log(x)$ is linear! Proof + illustrations
- ***The rule of 70***: if x grows at a constant rate g per year, then x will double in $70/g$ years. Proof + illustrations

A simple insight: stable growth brings higher incomes

If we combine the two concepts above, a simple picture emerges: countries that have higher growth rates for a longer periods of time will be richer than the rest. Indeed:

- Countries that began their growth take-offs earlier are more prosperous today (check the slide on income divergence again)
- The US economy has grown at a stable rate, without much contractions, for nearly 200 years - now it's (one of) the richest economy in the world
- Periods of growth followed by long periods of stagnation are common (growth disasters)
- Very high growth rates can elevate countries from poverty to prosperity in a matter of decades (growth miracles)

A simple insight: do we see stable growth among the rich economies? among the poorer ones?

As was shown by Lant Pritchett (2000) "Understanding Patterns of Economic Growth; Searching for Hills among Plateaus, Mountains, and Plains", growth dynamics differ a lot across countries! 'Hills' in developed:

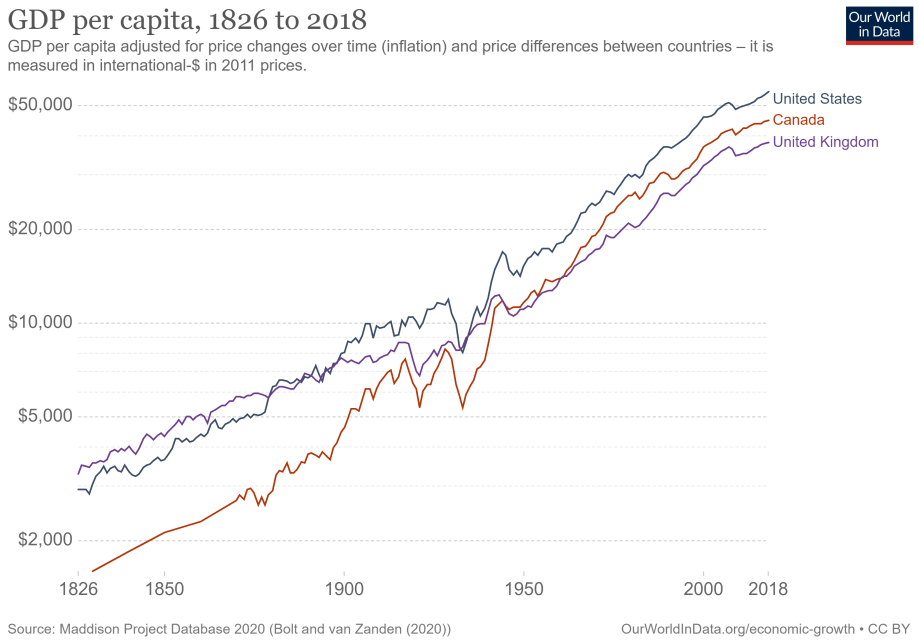


Figure 18: Growth "Hills" in developed countries. Source: ourworldindata.org

A simple insight: do we see stable growth among the rich economies? among the poorer ones?

Here are the episodes of 'Growth miracles', rapid catch-up growth:

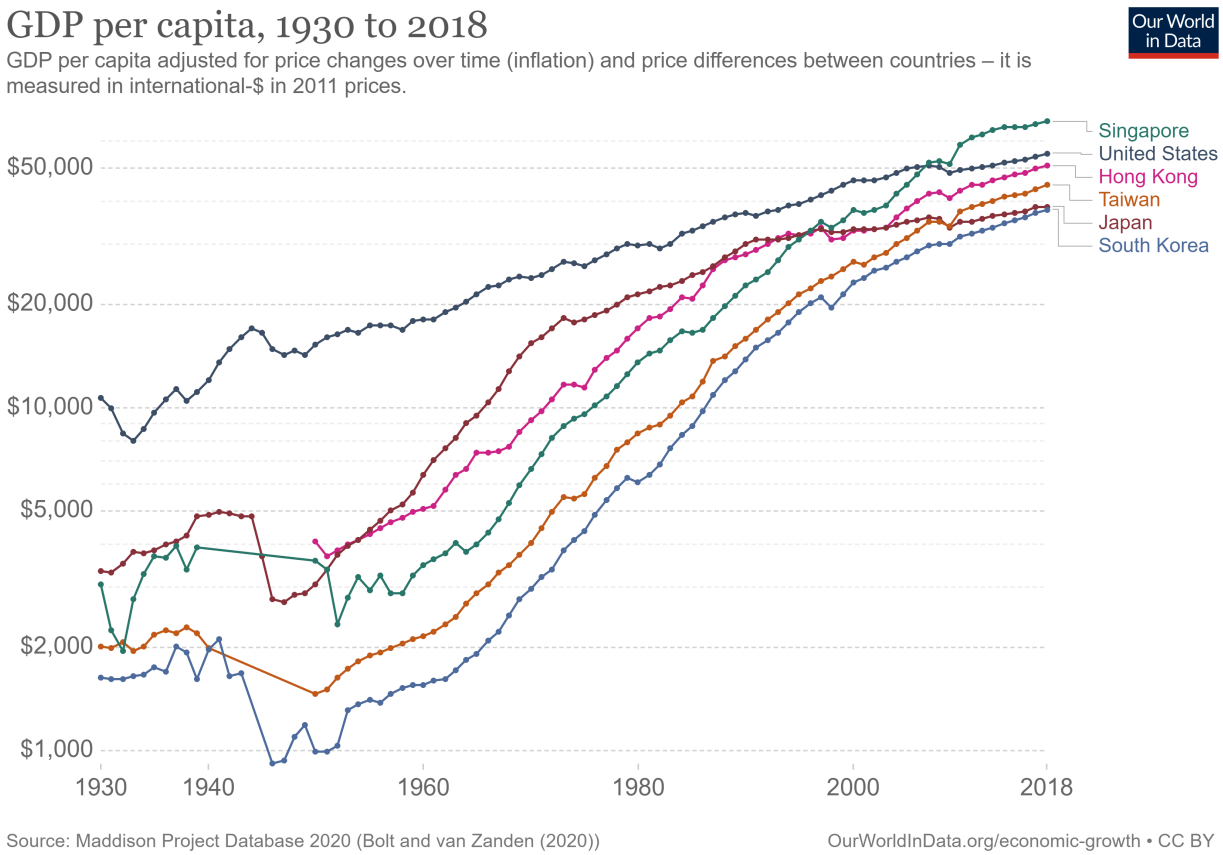


Figure 19: Growth "accelerations". Source: ourworldindata.org

A simple insight: do we see stable growth among the rich economies? among the poorer ones?

And here are various other paths in LDCs and developing countries:

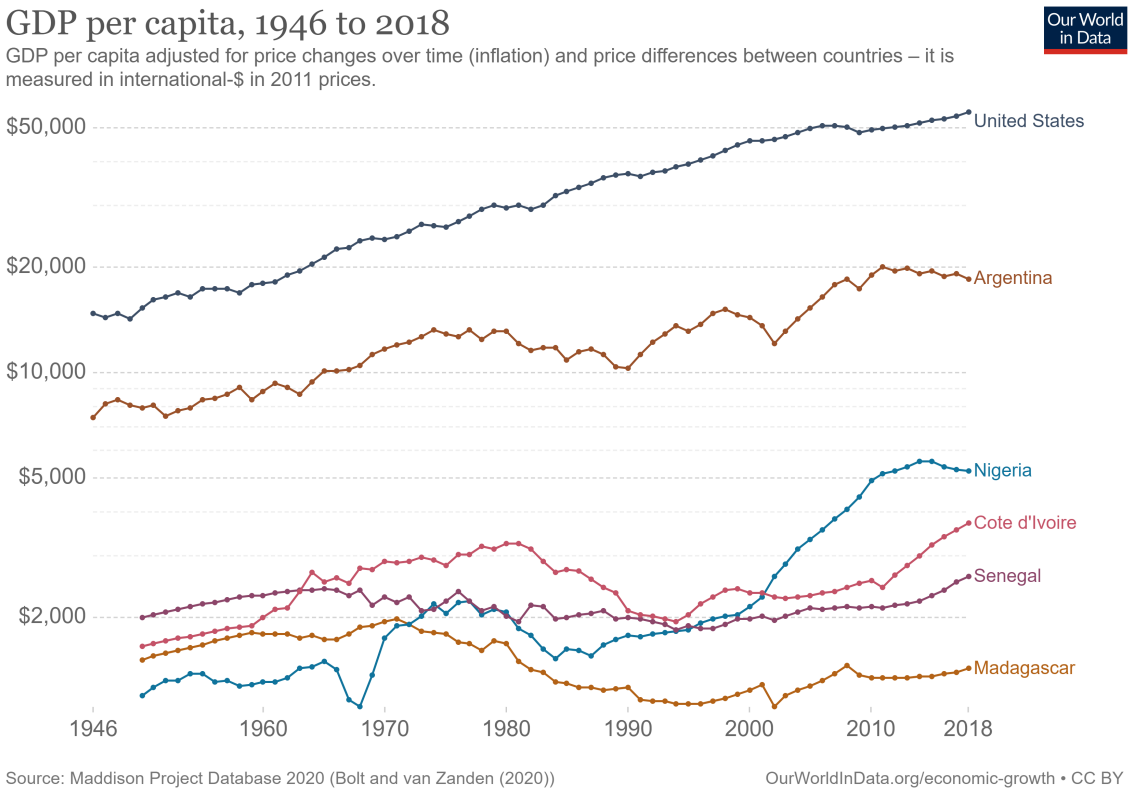


Figure 20: "Plains", "Mountains", etc. in LDCs and developing countries. Source: ourworldindata.org

Do we really measure something important with GDP per capita?

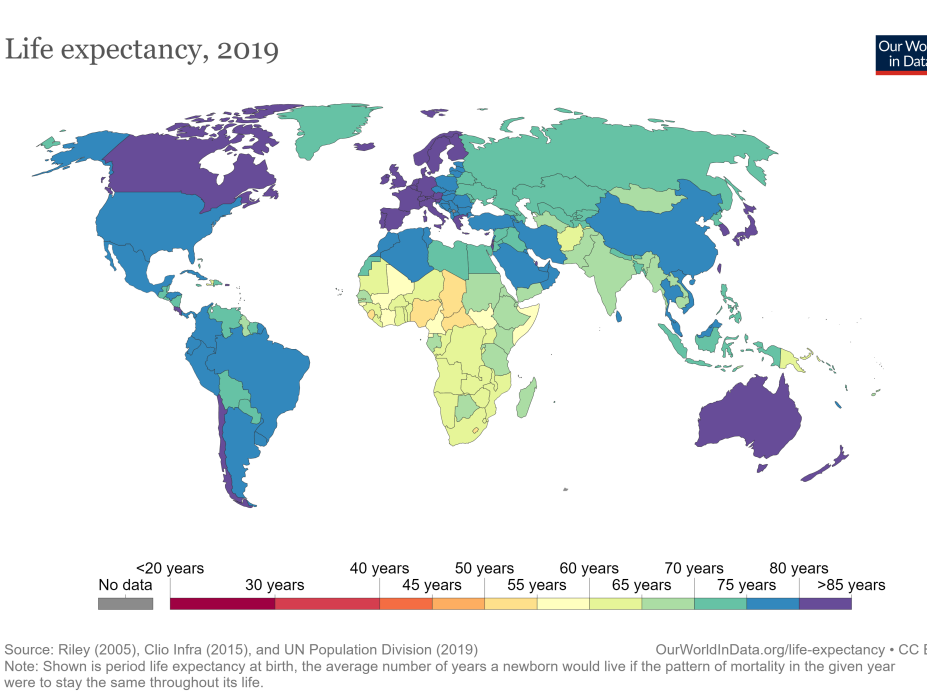
As Leo Tolstoy wrote in his novel "Anna Karenina",

"Happy families are all alike; every unhappy family is unhappy in its own way"

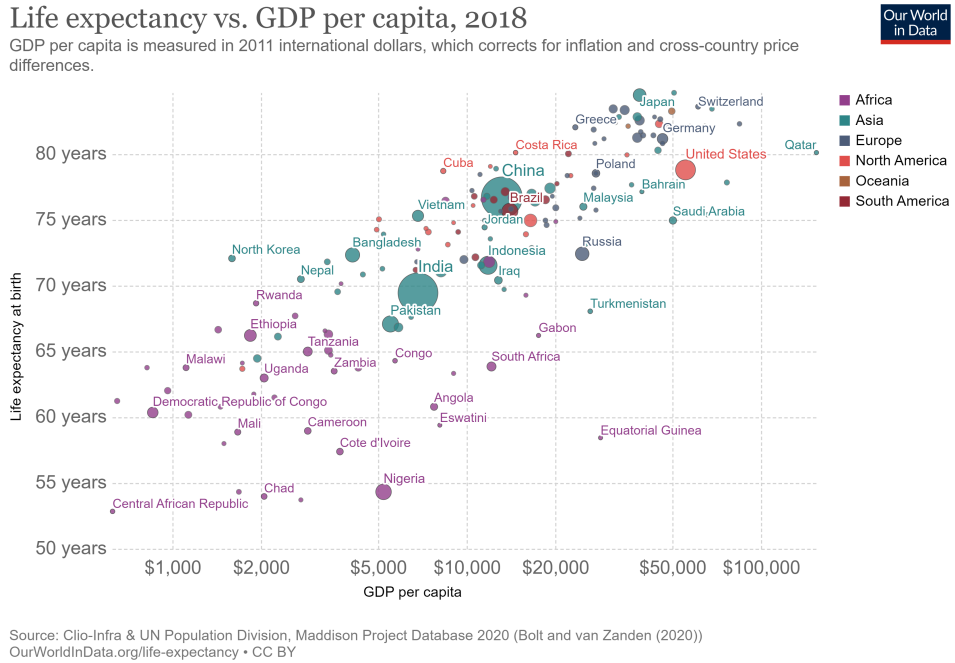
Quite similarly, all 'happy' countries share similar attributes, all of which are strongly associated (correlated) with GDP per capita:

- life expectancy
- education
- self-reported happiness
- and many other things

Life expectancy and incomes per capita



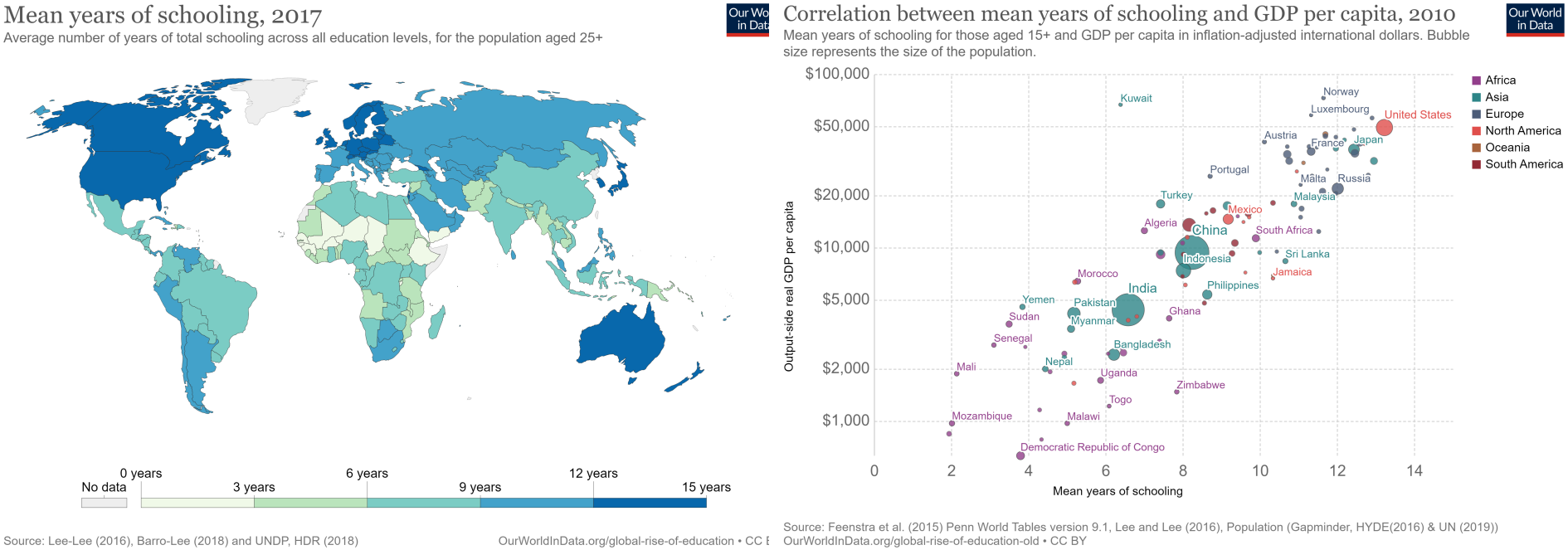
(a) Life expectancy by country, 2019



(b) Correlation between life expectancy and GDP per capita, 2018

Figure 21: Life expectancy and GDP per capita across the world. Source: ourworldindata.org

Education and incomes per capita



(a) Mean years of schooling by country, 2017

(b) Correlation between mean years of schooling and GDP per capita, 2010

Figure 22: Mean years of schooling and GDP per capita across the world. Source: ourworldindata.org

Can money buy happiness?

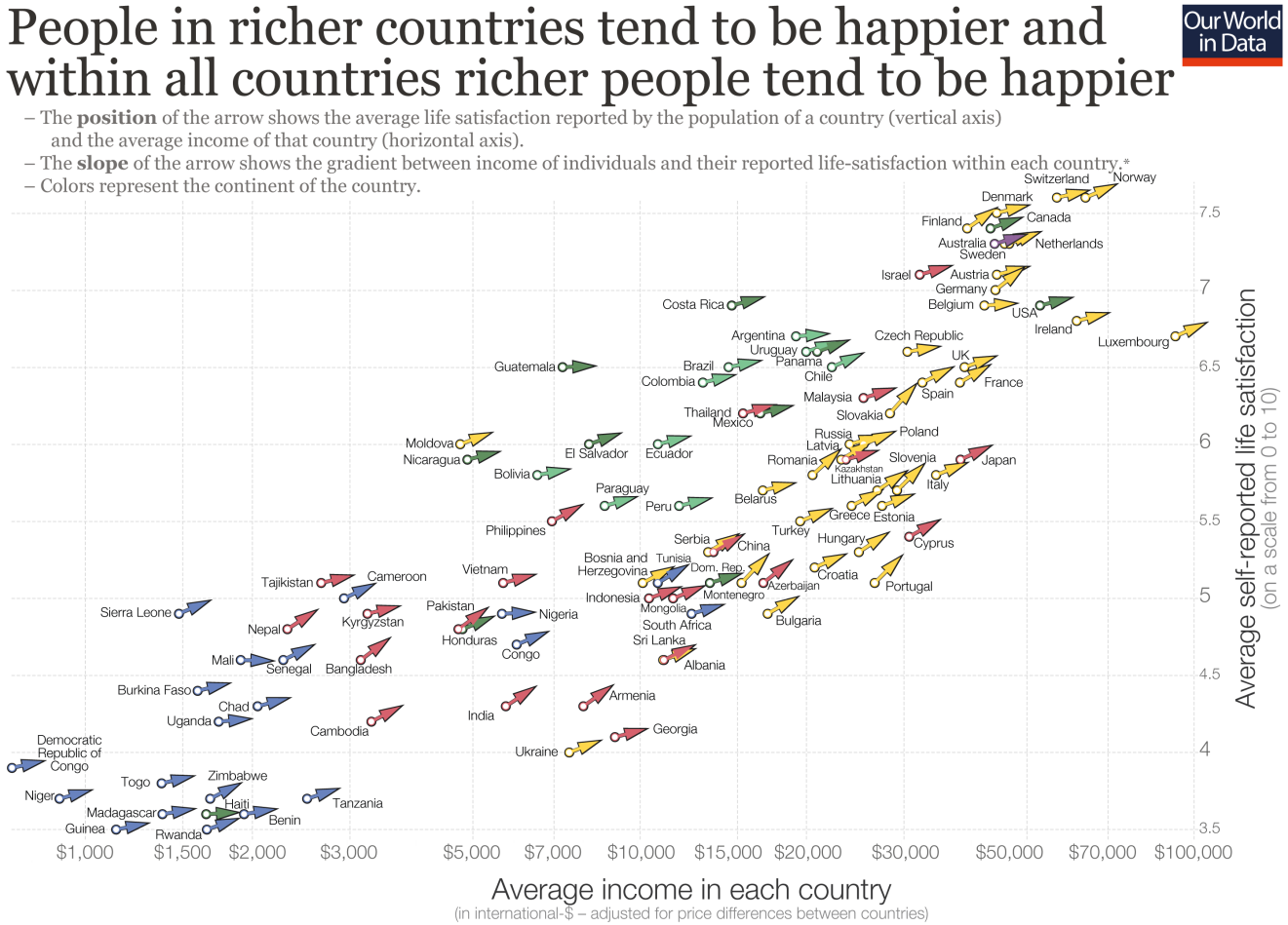


Figure 23: Self-reported life satisfaction across and within countries, and incomes. Source: ourworldindata.org

What do we learn from these scatterplots?

Above, we saw some *time series* and *correlations*. It's crucial to remember:

- Correlation does not imply causation! For example, we don't know whether better institutions increase GDP per capita, or vice versa (or both).
  - Or maybe there are other factors (that we haven't thought of or measured) that affect both institutions and GDP per capita...
- We don't (yet!) know what lies behind the dynamics we saw. For example, *why* had certain countries suddenly started to grow in the 18th century and not earlier/later?
- We can always go one step 'deeper' in our questions of 'why':
  - If education helps economic growth, then why some counties invest more in education?
  - If certain political institutions are conducive to investments in education, then why don't we see such institutions across the globe? ... and so on...

Table of Contents

The 'conceptual framework' for this course

In this course, we will go step-by-step, digging deeper into these questions of 'why'.
First, let's take a look at so-called 'proximate'('immediate') causes of growth and prosperity: factors of production and technologies

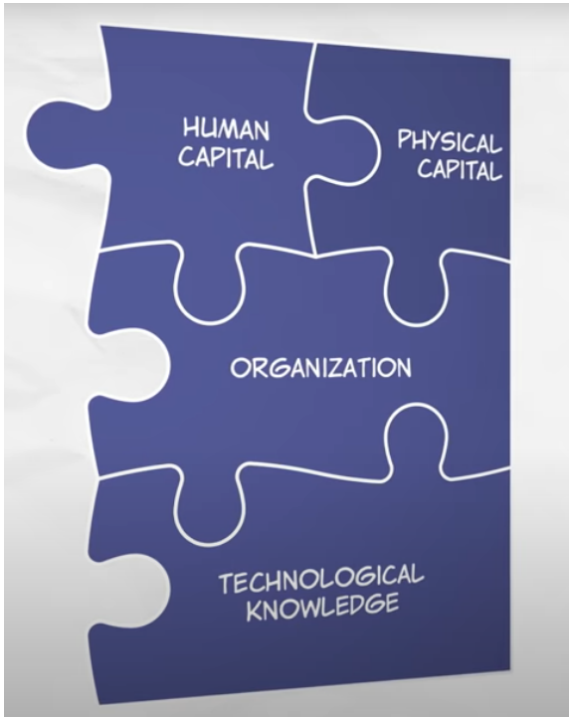


Figure 24: Factors of production and technologies as immediate causes of growth. Source: Tabarrok and Cowen, MRU lecture slides

The 'conceptual framework' for this course: production factors and productivity

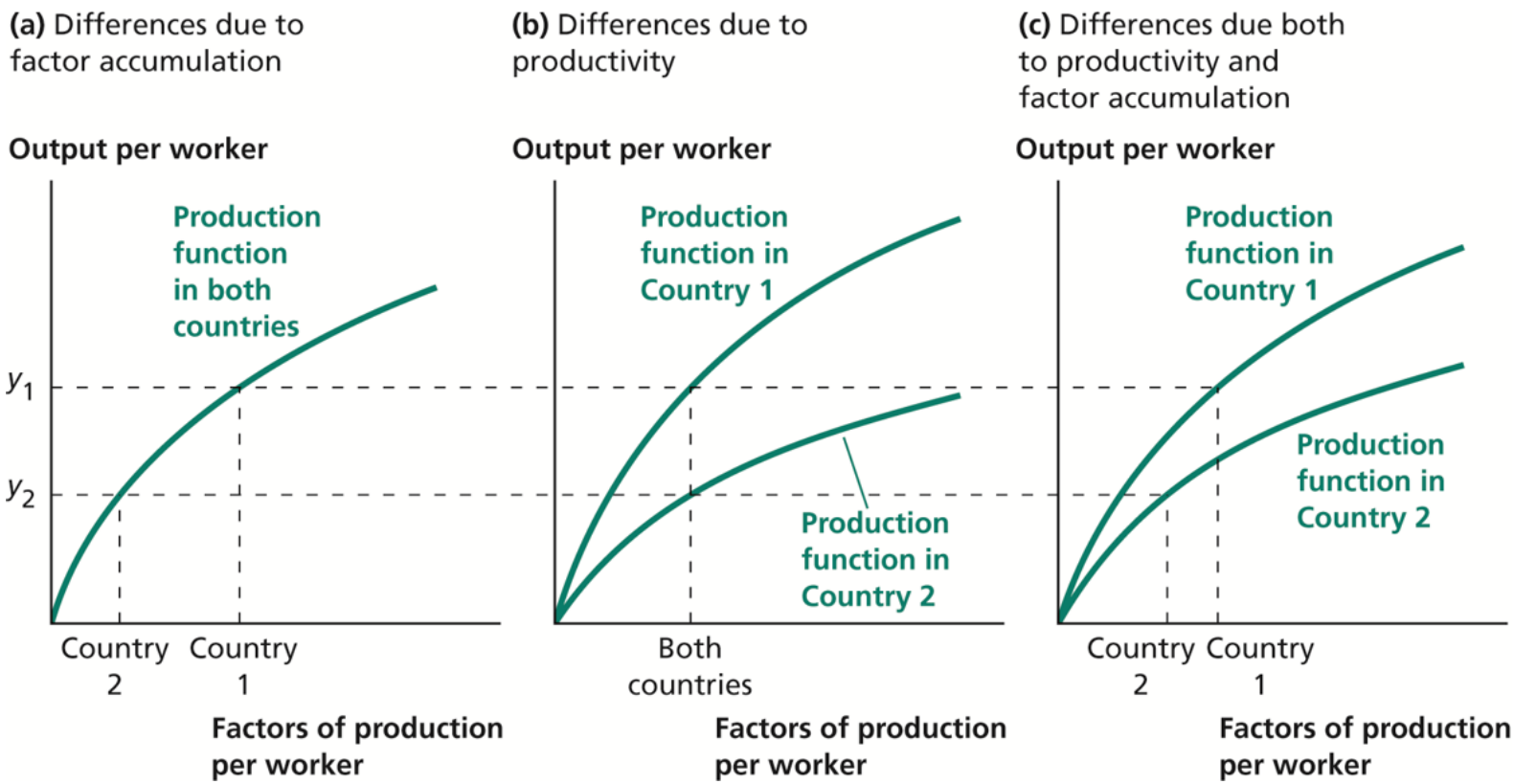


Figure 25: Factors of production vs technological differences as immediate causes of growth. Source: David Weil "Economic Growth" (3rd ed.)

The 'conceptual framework' for this course: incentives matter

But why do certain countries and regions accumulate more factors of production, and why do they organize them better and have better technologies?

Key principle of Economics: Incentives matter!

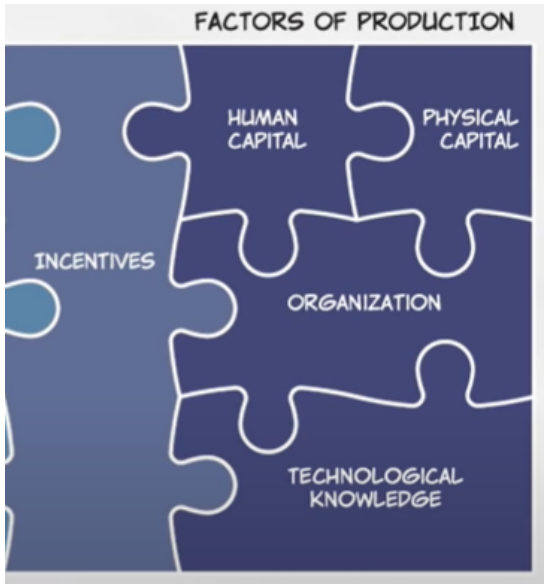


Figure 26: Incentives affect factors accumulation as well as technologies and the way all is organized. Source: Tabarrok and Cowen, MRU lecture slides

The 'conceptual framework' for this course: the role of institutions

But why do certain countries and regions provide incentives conducive for investment, innovation, and growth, while others do not?

Institutions (formal rules of the game) matter!

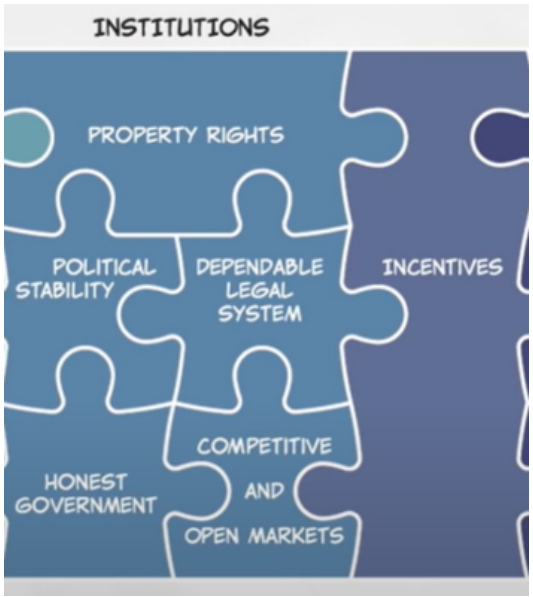


Figure 27: Key institutions shape incentives that people face. Source: Tabarrok and Cowen, MRU lecture slides

The 'conceptual framework' for this course: deep roots of development

But why do certain countries and regions have inclusive institutions that provide right incentives? While other countries have corrupt governments, monopolized markets, and insecure property rights?

This is where it gets most complicated (and interesting! well, at least to me): the role of history, culture, geography, luck, even biology!

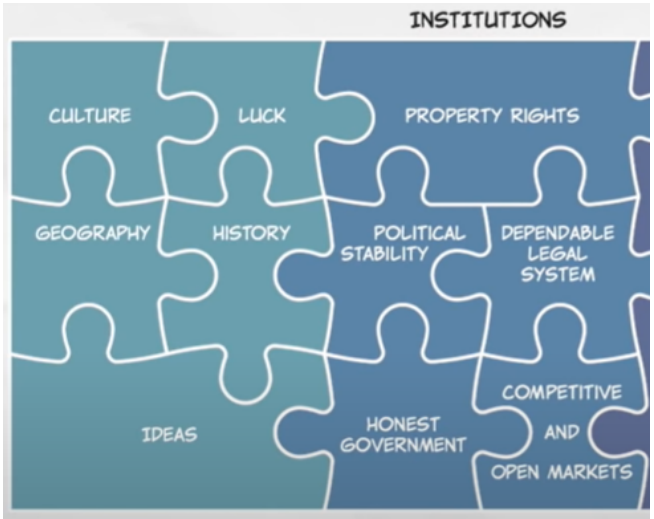


Figure 28: Historical accidents, geography, culture, and other factors interplay with institutions in a complex manner. Source: Tabarrok and Cowen, MRU

The 'conceptual framework' for this course: the puzzle completed?

Together, these pieces form a (variant of!) conceptual framework with causal links (what causes what):

- incentives drive factor accumulation and hence income differences
- differences in institutions explain differences in incentives and thus differences in factors accumulation
- deeper factors, such as geography and culture, affect institutions, and hence all other proximate factors...

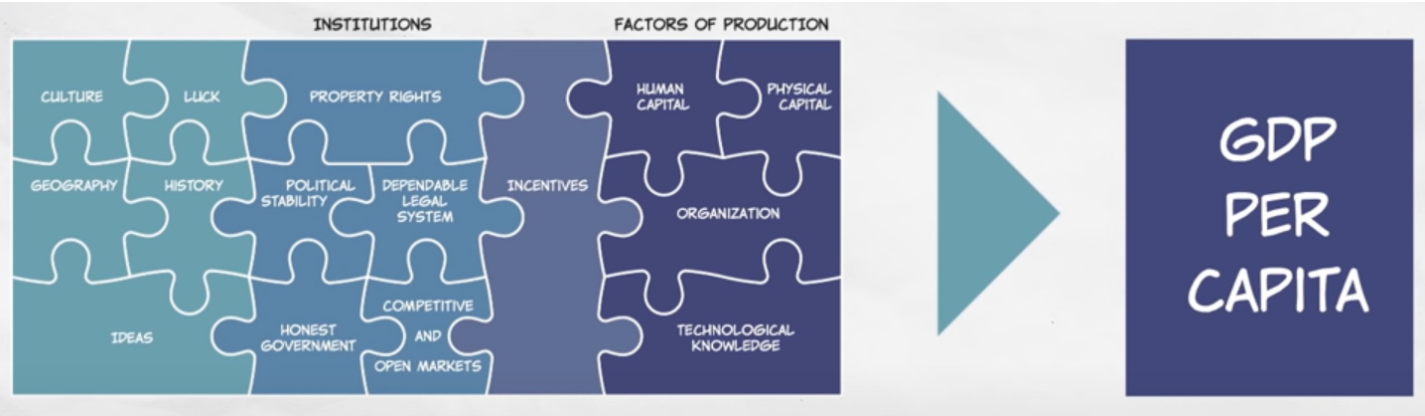


Figure 29: Growth puzzle completed? Source: Tabarrok and Cowen, MRU

The 'conceptual framework' for this course: the puzzle completed?

- However, do we really understand *how* human capital or physical capital cause growth?
- Is there no way that differences in GDP per capita or Human capital can *cause* differences in institutions?
- Can institutions affect culture?
- How persistent are the effects of historical shocks?

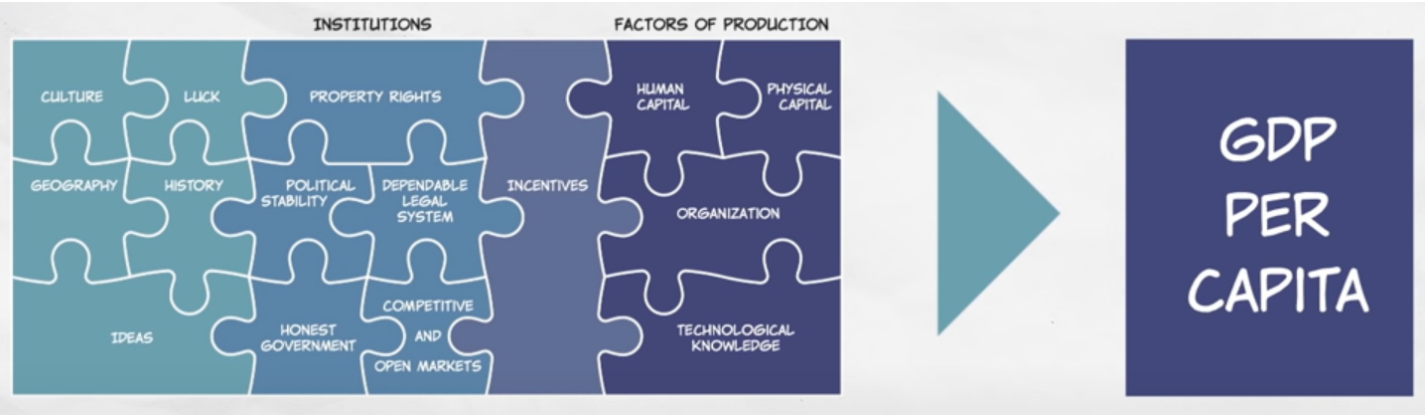


Figure 30: Growth puzzle completed? Source: Tabarrok and Cowen, MRU

Table of Contents

Natural logarithms

Mathematical expression $y = log_a(x)$ means that y is the power to which the base (a) needs to be raised to produce x. Thus, $y = log_b(b^y)$

For example, $log_2(8) = 3$ because $log_2(8) = log_2(2^3)$

Natural logarithm stands for base $a = e$, where $e = 2.71828...$ (Eurler's number). Thus, natural logarithm gives a power to which e needs to be raised to produce x.

We often omit writing base $a = e$, and write $y = ln(x)$ - stands for natural logarithm.

In other words, $e^{ln(x)} = x$. Often $ln(x)$ and $log(x)$ are used interchangeably.

Back

Natural logarithms

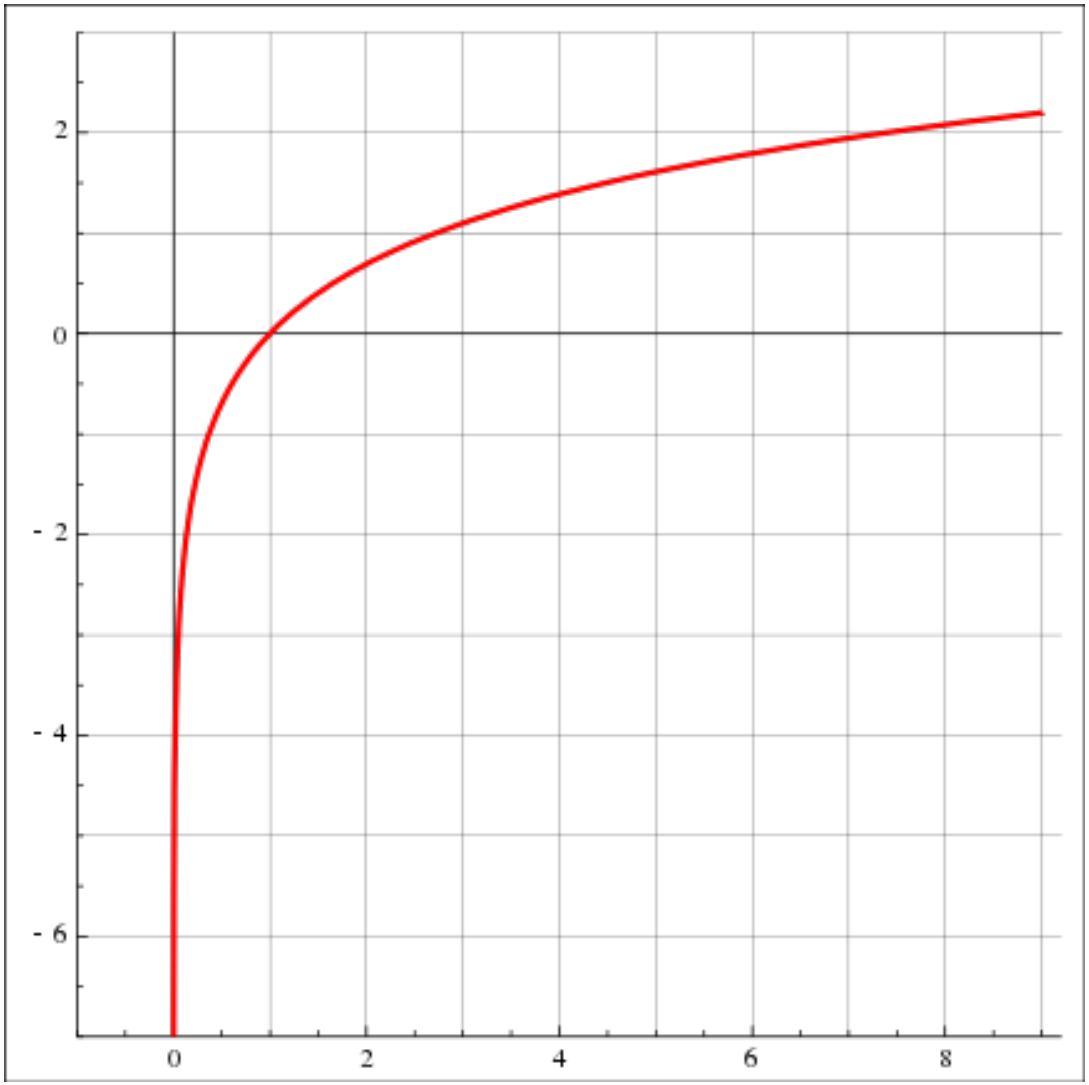


Figure 31: Natural logarithm. Source: Wiki

Key properties of natural logarithms

- $\ln 1 = 0$
- $\ln e = 1$
- $\ln(xy) = \ln x + \ln y \quad \text{for} \quad x > 0 \text{ and } \quad y > 0$
- $\ln(x^y) = y \ln x \quad \text{for} \quad x > 0$
- $\ln x < \ln y \quad \text{for} \quad 0 < x < y$
- $\lim_{x \to 0} \dfrac{\ln(1+x)}{x} = 1$

Figure 32: Key properties of natural logarithms. Source: Wiki

Key properties of natural logarithms: let's exercise!

Natural logarithm and growth rates

If a variable x has a constant growth rate g, then it means that $x_{t+1} = x_t \cdot (1+g)$. Hence, $x_{t+2} = x_t \cdot (1+g)^2$... Eventually, for any period t, $x_t = x_0 \cdot (1+g)^t$. This is an exponential function of time t (with parameter g: the higher g, the faster growth).

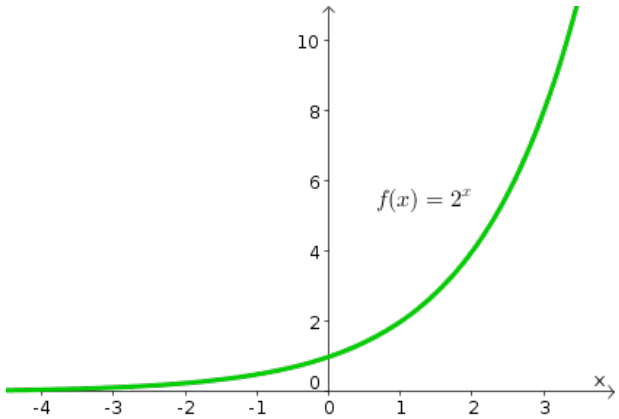


Figure 33: Example of an exponential function. Source: mathinsight.org

Back

Natural logarithm and growth rates

Now, if $x_t = x_0 \cdot (1+g)^t$, then, applying natural logs to both sides, we get:

$$log(x_t) = log(x_0 \cdot (1+g)^t)$$

Simplifying, we get:

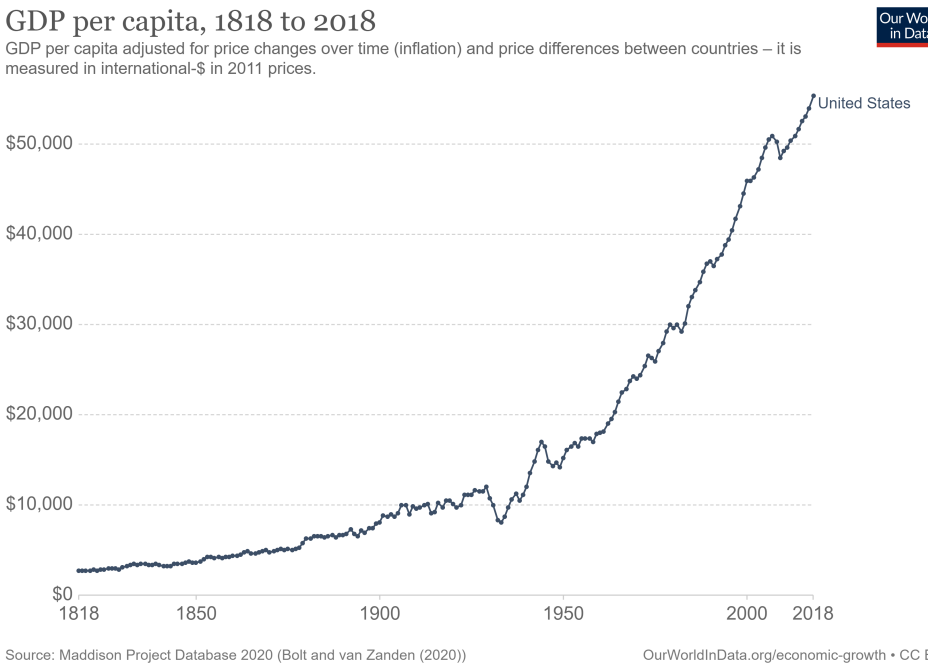
$$log(x_t) = log(x_0) + t \cdot log(1+g)$$

And using the approximation of logs:

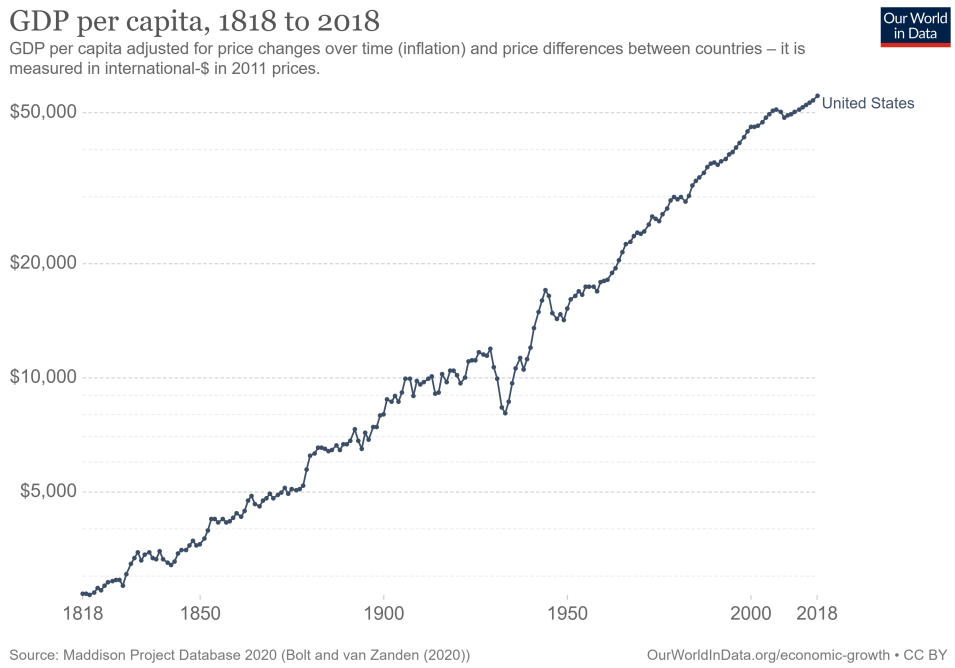
$$log(x_t) \approx log(x_0) + t \cdot g$$

Notice that the logarithm of x_t is a linear function of time t! Slope of this linear function equals g.

Natural logarithms and growth rates: Illustration



(a) GDP per capita dynamics, linear scale



(b) GDP per capita dynamics, log scale

Figure 34: GDP per capita in the US. Left - linear scale; Right - log scale. Source: Our World in Data

More on natural logarithm and growth rates

From properties of logarithms (and also using some basic calculus), it is easy to show how to calculate growth rates of a product and of an exponential functions:

- Let $y = x \cdot z$. Then the growth rate of y is equal to $g_y = g_x + g_z$
- Let $y = x^\alpha$. Then $g_y = \alpha \cdot g_x$
- Combining the two properties, if $y = x^\alpha \cdot z^\beta$, then $g_y = \alpha \cdot g_x + \beta \cdot g_z$
- In all these calculations we assume that y, x, z are all functions of time (i.e., vary with time).

Rule of 70: proof

Assume GDP per capita y_t grows at a constant rate g.

Then, relative to the previous period, $y_t = y_{t-1} \cdot (1+g)$.

Iterating again, we get that $y_t = y_{t-2} \cdot (1+g) \cdot (1+g) = y_{t-2} \cdot (1+g)^2$

Iterating t times, we will get that $y_t = y_0 \cdot (1+g)^t$.

The ratio between current and initial GDP equals $y_t / y_0 = (1+g)^t$.

If GDP per capita has doubled over the period from 0 to t, it means that $2 = (1+g)^t$. Taking natural logs, we get: $log(2) = t \cdot log(1+g)$.

Finally, we use the approximation, $log(1+g) \approx g$, to get that $t = log(2)/g \approx 0.7/g$ - this is the Rule of 70 that we use!

Back