LSE EC1B5 Macroeconomics

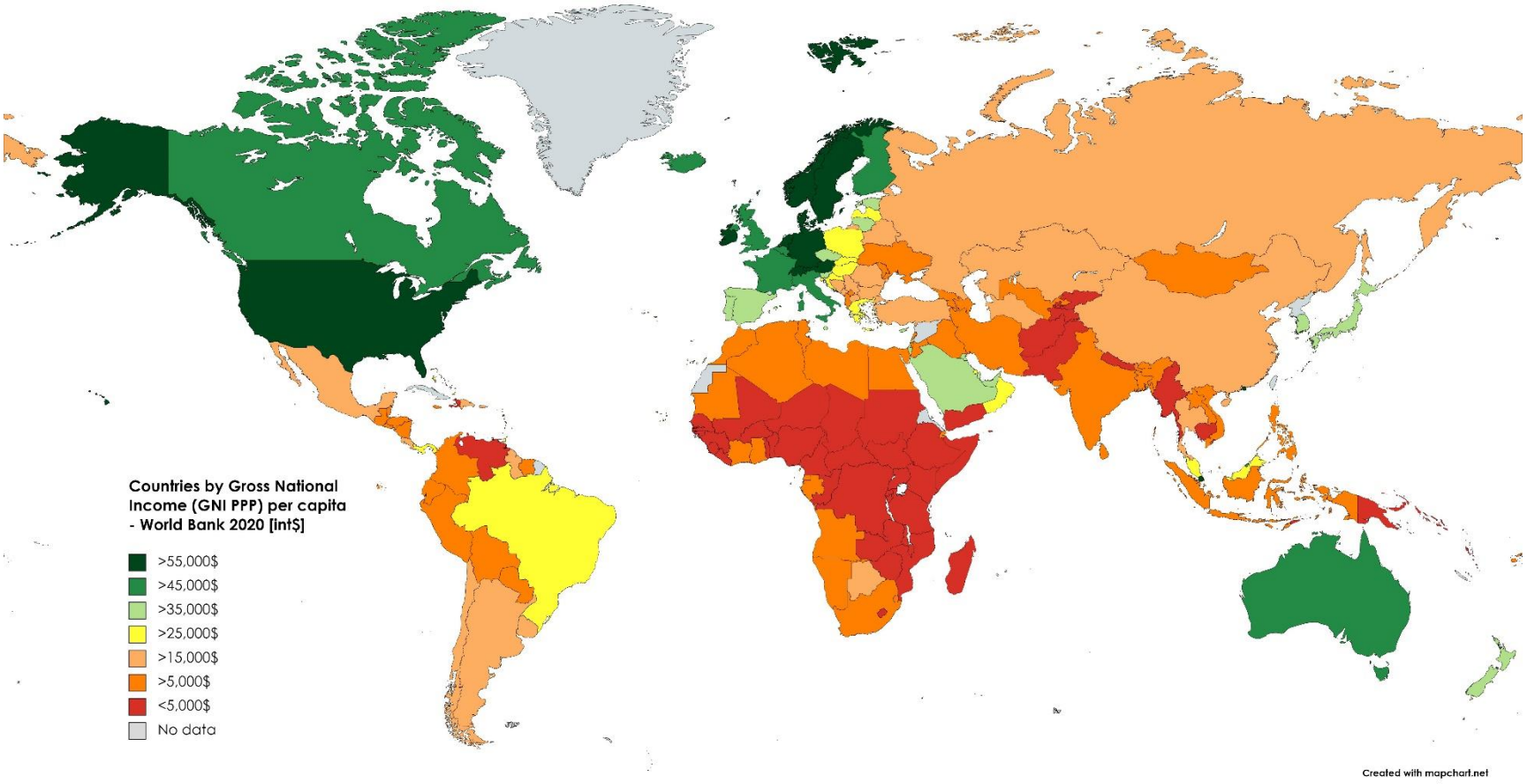
Handout 3

Inequality Around the World

Key Ideas

- Comparing GDP across countries, adjusted for purchasing power parity (PPP).
- There are very large differences across countries in GDP per capita and GDP per worker.
- Aggregate Production Function
- Accounting for cross-country income/productivity: physical capital, human capital and technology
- We turn to a **long-run** view of the economy

Inequality Around the World 2021



A Map of Income per Capita Around the World

Comparing GDP across countries

We use the two terms, **income per capita** and **GDP per capita**, interchangeably in this course:

$$\text{Income per capita} = \text{GDP per capita} = \frac{\text{GDP}}{\text{Total population}}$$

Comparing GDP across countries

United States in 2019

GDP = $21.43 trillion
Population = 329 million persons

GDP per capita = $ 65,134 per person

Comparing GDP across countries

Peru in 2019

GDP = 757.060 billion nuevo sols
Total population = 33 million people

GDP per capita = 23,287 sols per person

Comparing GDP across countries

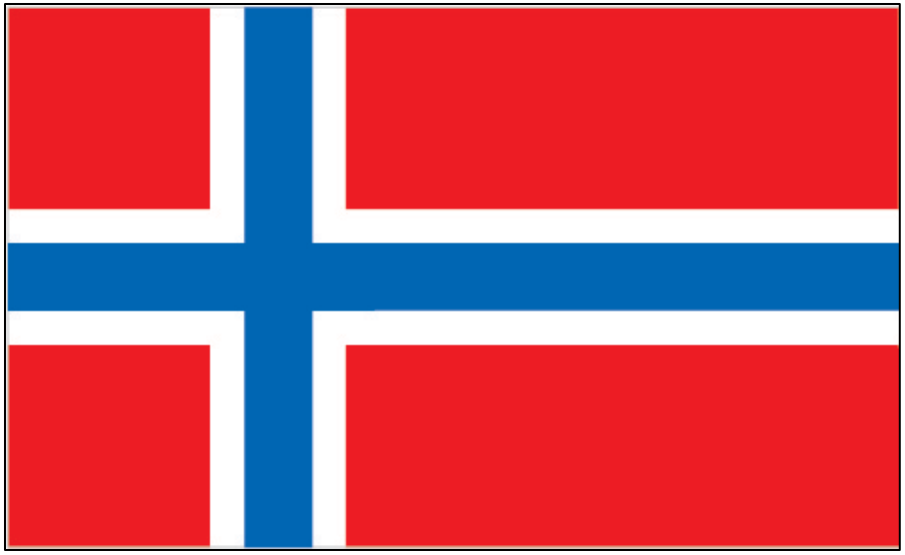
Norway in 2019

GDP = 3.55 trillion kroner
Total population = 5.38 million people

GDP per capita = 659,873 kroner per person

Comparing GDP across countries

Question: How does U.S. GDP compare with GDP in Peru and Norway?



Norway GDP in 2019, Using Exchange Rates

GDP per capita = Norway GDP per capita in kroner × exchange rate ($ / kroner)

GDP per capita =659,873kroner per person × 1/8.8 ($ / kroner)

= $74,986 per person

Peru GDP in 2019, Using Exchange Rates

GDP per capita = Peru GDP per capita in sols × exchange rate ($ / sol)

GDP per capita = 23,287 sols per person × 1/3.34 ($ / sol)

= $6,978 per person

GDP per Capita Rankings, Using Exchange Rates

2009 ranking	2019 ranking	Country	GDP per Capita 2019
2	1	Luxembourg	115,481
5	2	Switzerland	85,135
8	3	Ireland	81,637
12	6	United States	65,134
122	82	China	10004
114	101	Peru	6,978
200	206	Malawi	435
207	207	Burundi	260
208	208	Somalia	105

Comparing GDP across countries

Question: How do we make GDP comparisons between the United States and Peru and Norway?

Method #1: Convert GDP into U.S. dollars, using current exchange rates:

GDP per capita = GDP per capita in local currency × exchange rate ($ / local currency)

Comparing GDP across countries

Question: How do we make GDP comparisons between the United States and Peru and Norway?

Method #2: Convert Peru GDP by using the prices of goods and services in Peru relative to the prices of the same goods and services in the United States (*purchasing power parity*):

GDP per capita = GDP per capita in local currency × PPP adjustment

What is PPP?

- It's the relative cost of a basket of goods in two different locations, it's a measure of purchasing power.
- It's an exchange rate that can be used to compare standards of living
- Suppose there is only one good, rice, which costs 3 dollars unit in the US and 1 sol in Peru. Then PPP for the individual good here is 3 (dollars/sol)
- Aggregate PPP in Peru: 5.85 sol/dollar vs. exchange rate 3.34 sol/dollar

Peru GDP in 2019, Using PPP Adjustment

GDP per capita = Peru GDP per capita in sol × PPP adjustment ($ / peso)

GDP per capita =23,287sol per person × 0.171($ / sol)

= $3,982

Norway GDP on 2019, Using PPP Adjustment

GDP per capita = Norway GDP per capita in kroner × PPP adjustment ($ / kroner)

GDP per capita = 659,873kroner per person × 0.118 ($ / kroner)

= $77,865

Comparing GDP across countries

Even though PPP adjustments raise the income levels of the developing countries, there are still very large disparities in income per capita across countries.

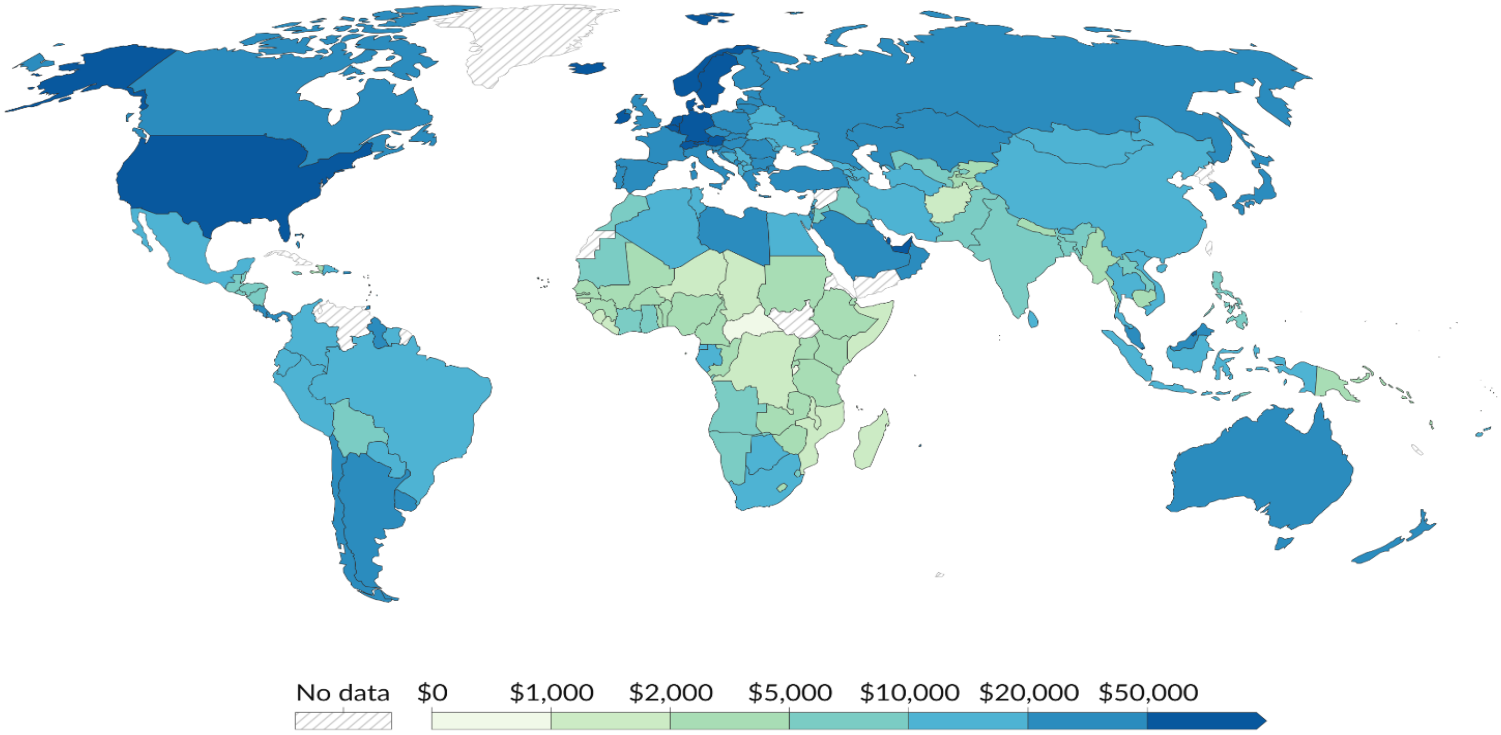
GDP per Capita Rankings PPP Adjustment, 2009 vs 2019

2009 ranking	2019 ranking	Country	GDP per Capita
1	1	Luxembourg	14,6109
3	2	Switzerland	96,593
21	3	Iceland	94,909
2	5	Norway	77,851
15	7	United States	67,880
122	75	China	7,132
112	92	Peru	3,979
162	206	Sudan	91
207	207	Burundi	85
208	208	Somalia	54

GDP per Capita Rankings, Exchange vs PPP 2019

Country	Exchange ranking	PPP ranking
Luxembourg	1	1
Switzerland	2	2
Ireland	3	8
United States	6	7
China	82	75
Peru	101	92
Malawi	206	203
Burundi	207	207
Somalia	208	208

GDP per capita (2021)



Data source: World Bank (2023)
Note: This data is expressed in international-$[1] at 2017 prices.

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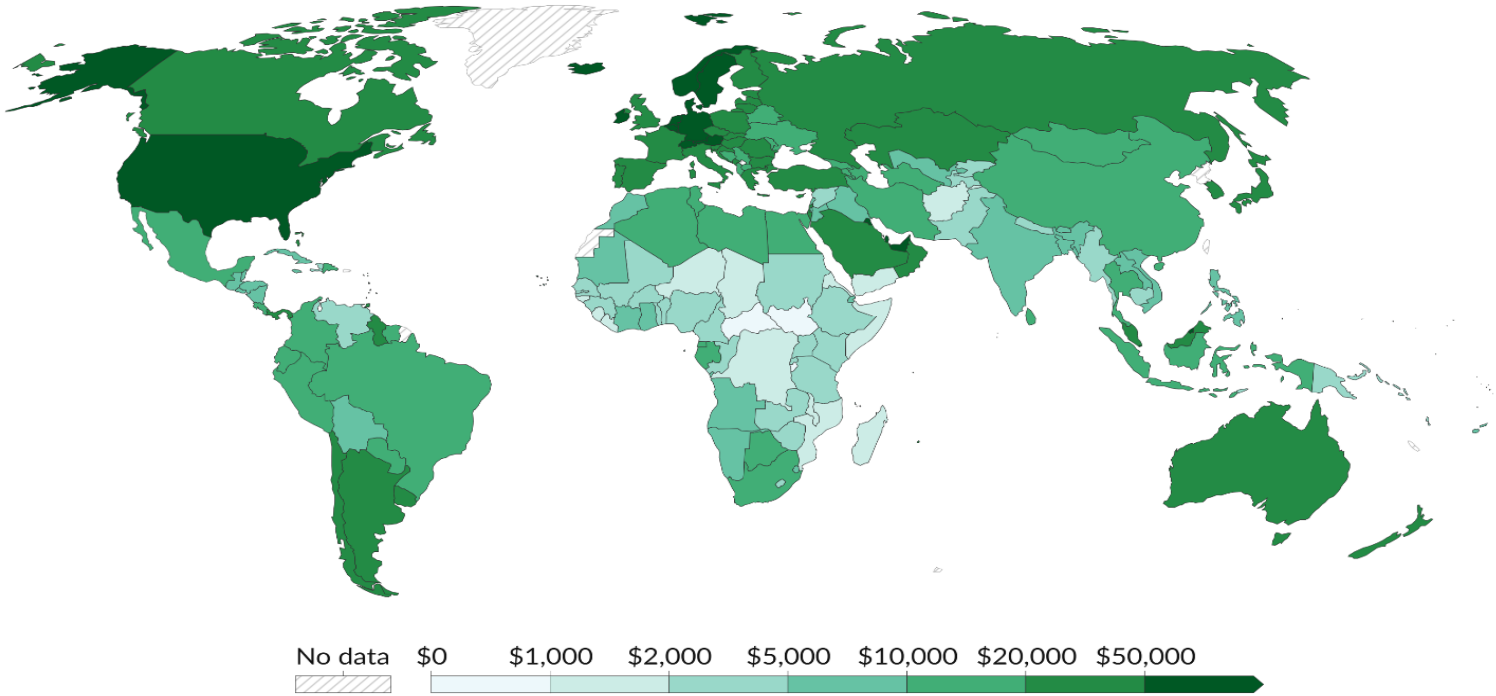
1. International dollars: International dollars are a hypothetical currency that is used to make meaningful comparisons of monetary indicators of living standards. Figures expressed in international dollars are adjusted for inflation within countries over time, and for differences in the cost of living between countries. The goal of such adjustments is to provide a unit whose purchasing power is held fixed over time and across countries, such that one international dollar can buy the same quantity and quality of goods and services no matter where or when it is spent. Read more in our article: What are Purchasing Power Parity adjustments and why do we need them?

Income per Capita Around the World in 2021 (PPP-adjusted 2017 constant dollars)



Data source: UNDP, Human Development Report (2021-22) (2022)
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Guns Germs and Steel

- What causes income differences?
- Economic views: capital stock, productivity, human capital…
- Institutions
- Geography
  - *Guns, Germs and Steel*
  - Jeff Sachs

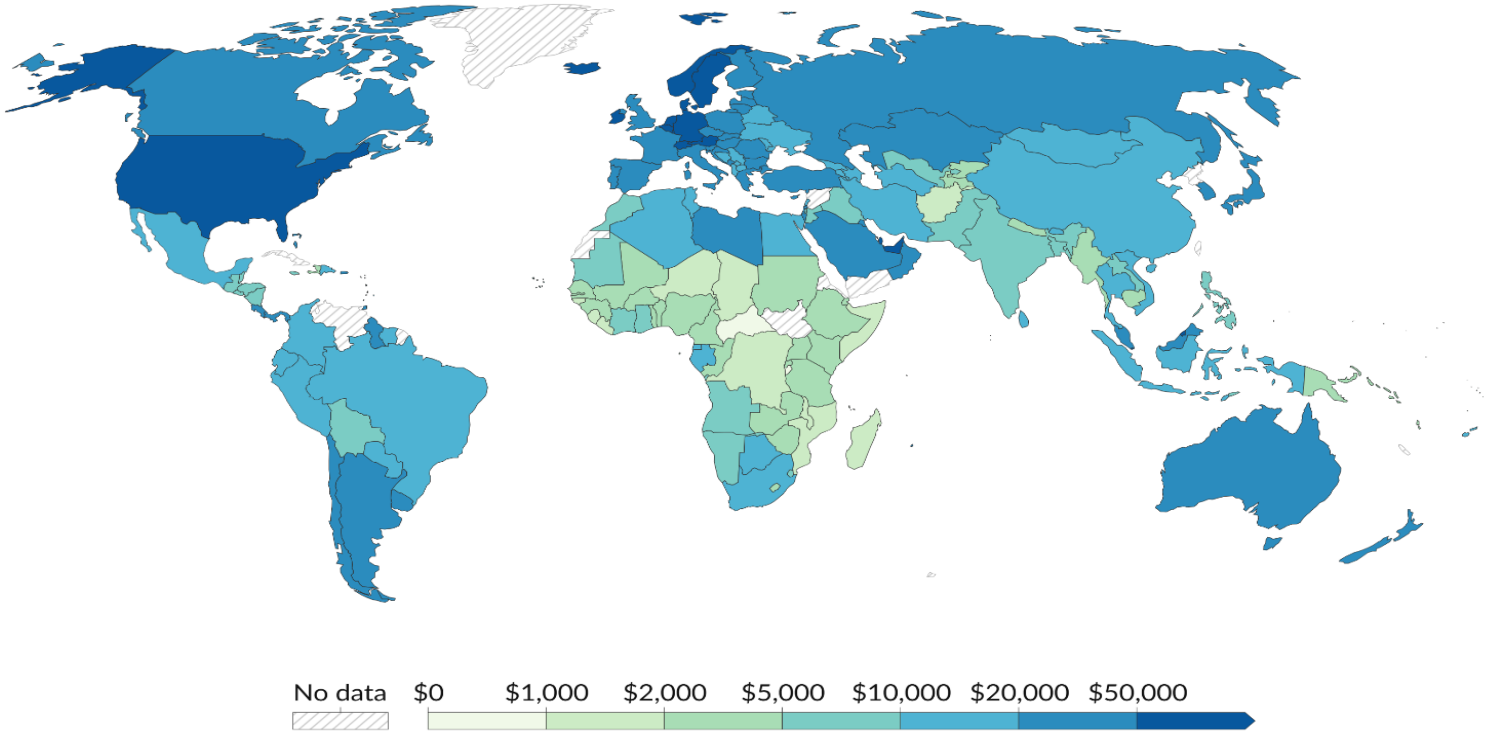
Productivity Differences

How Do You Measure Productivity?

Two types of productivity

- Total factor productivity (TFP): output growth not due to capital or labor (Solow residual)
- Labor productivity: GDP/hours worked
- Capital productivity

GDP per capita (2021)



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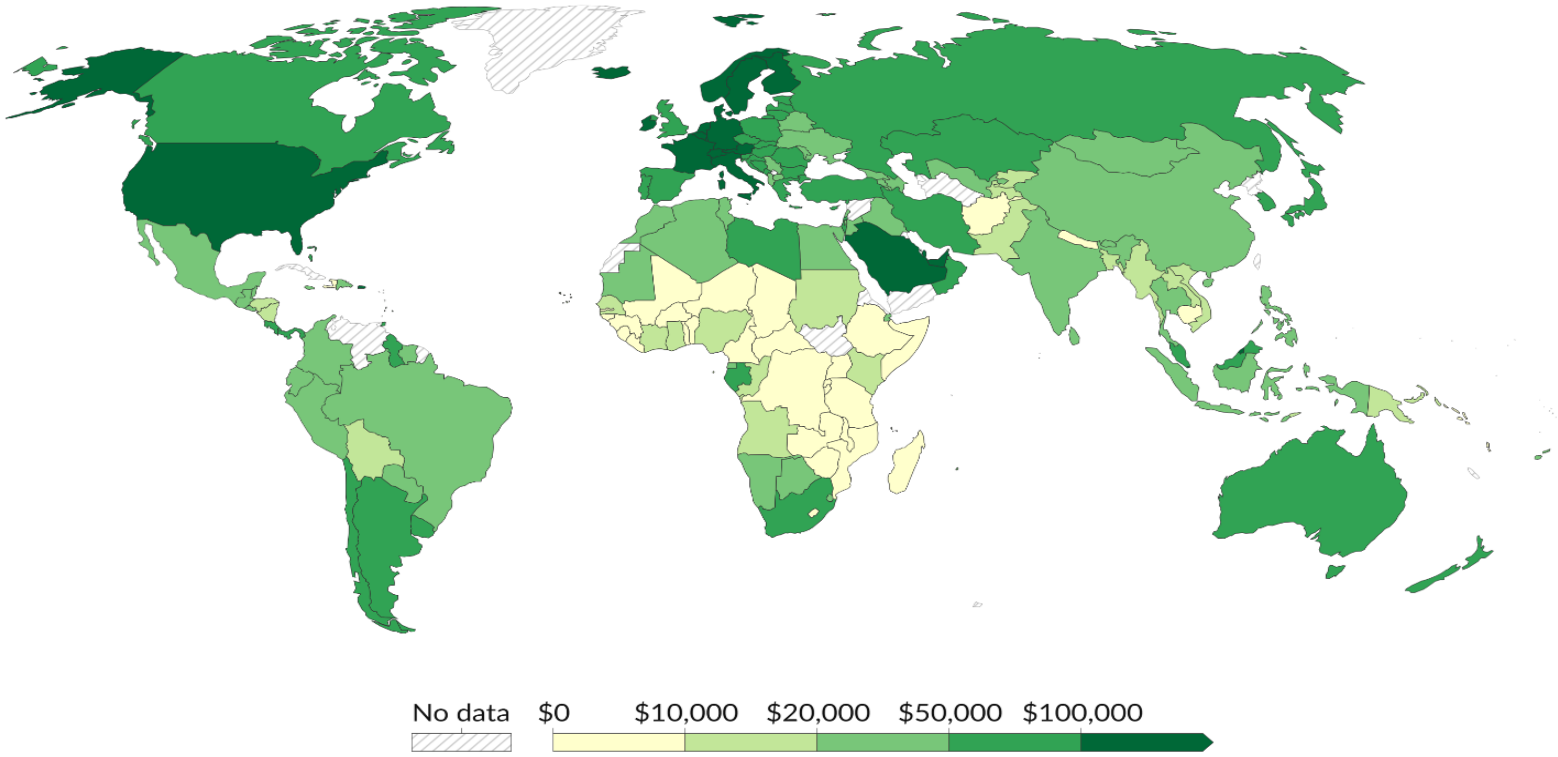
Productivity Differences – GDP per worker (2021)



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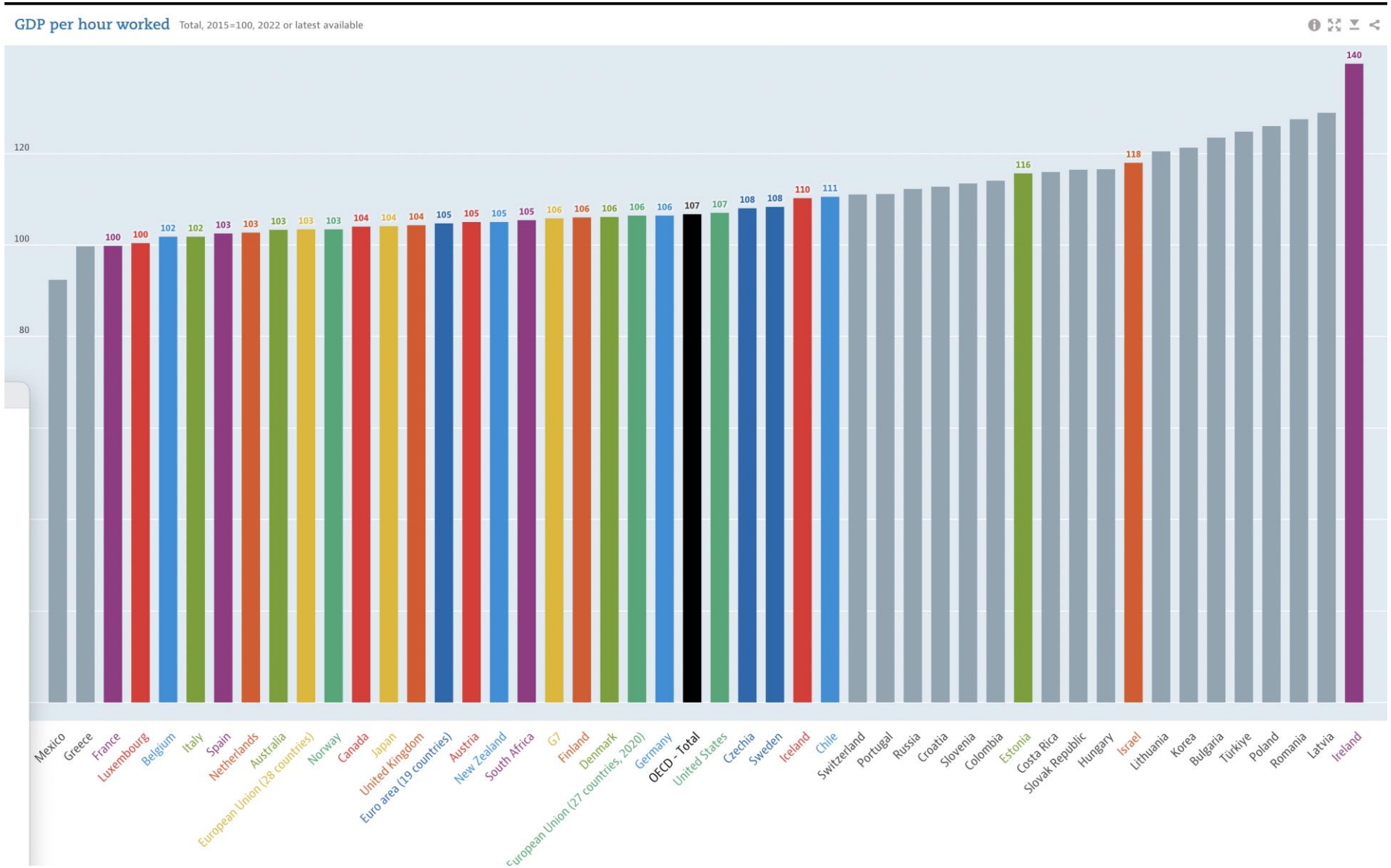
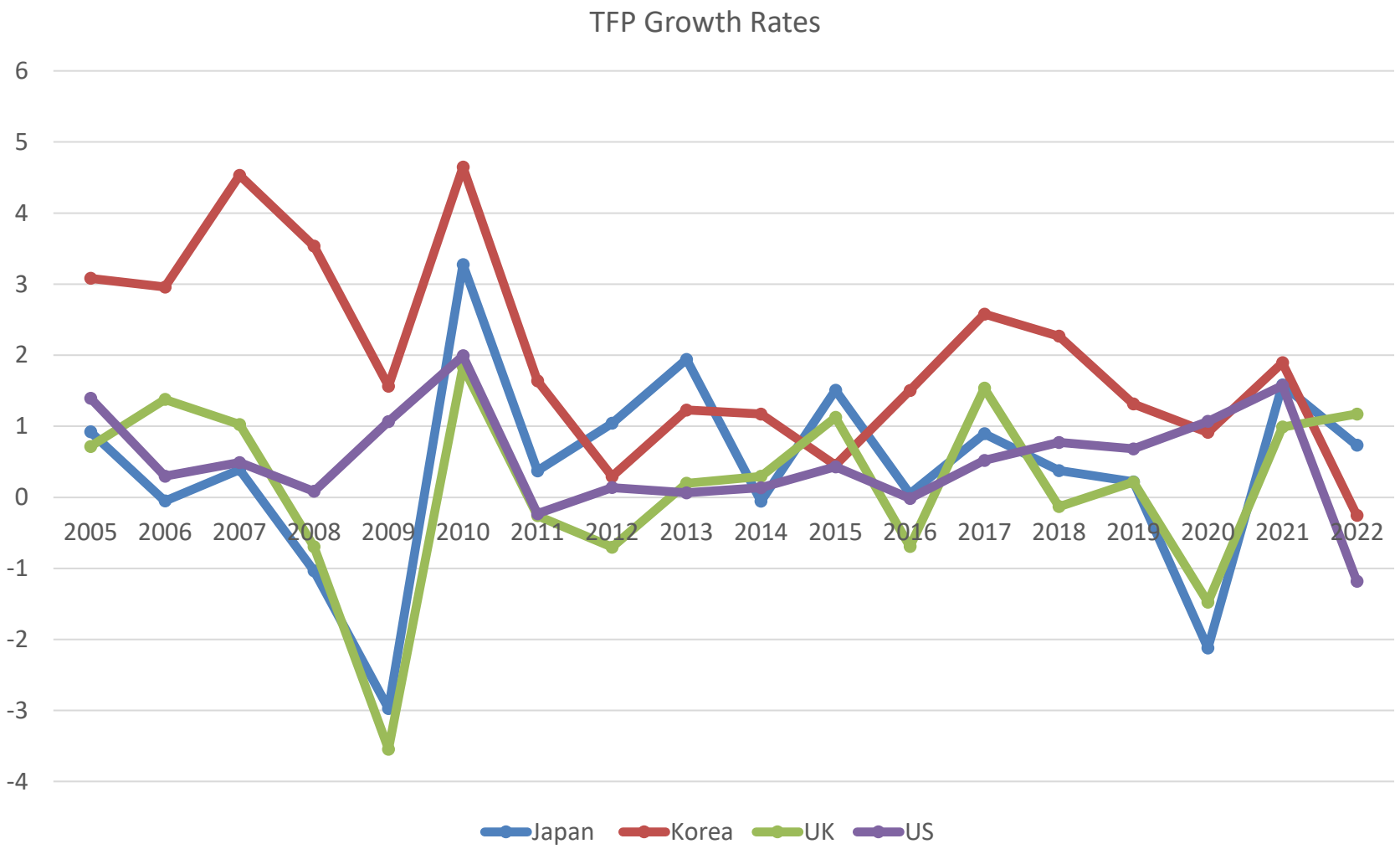
GDP per Capita vs. GDP per Worker (2021)

Ranking	Country	GDP per Capita	GDP per Worker
1	Luxembourg	115,683.49	233,958.55
2	Singapore	106,032.23	182,387.84
3	Ireland	102,496.22	219,465.67
11	United States	63,669.71	135,640.78
112	Peru	12,514.65	24,159.43
202	Democratic Republic of Congo	1,073.64	3,261.13
203	Central African Republic	837.50	2,428.39
204	Burundi	705.03	1,709.30

Labor productivity



TFP growth (2006-2022)

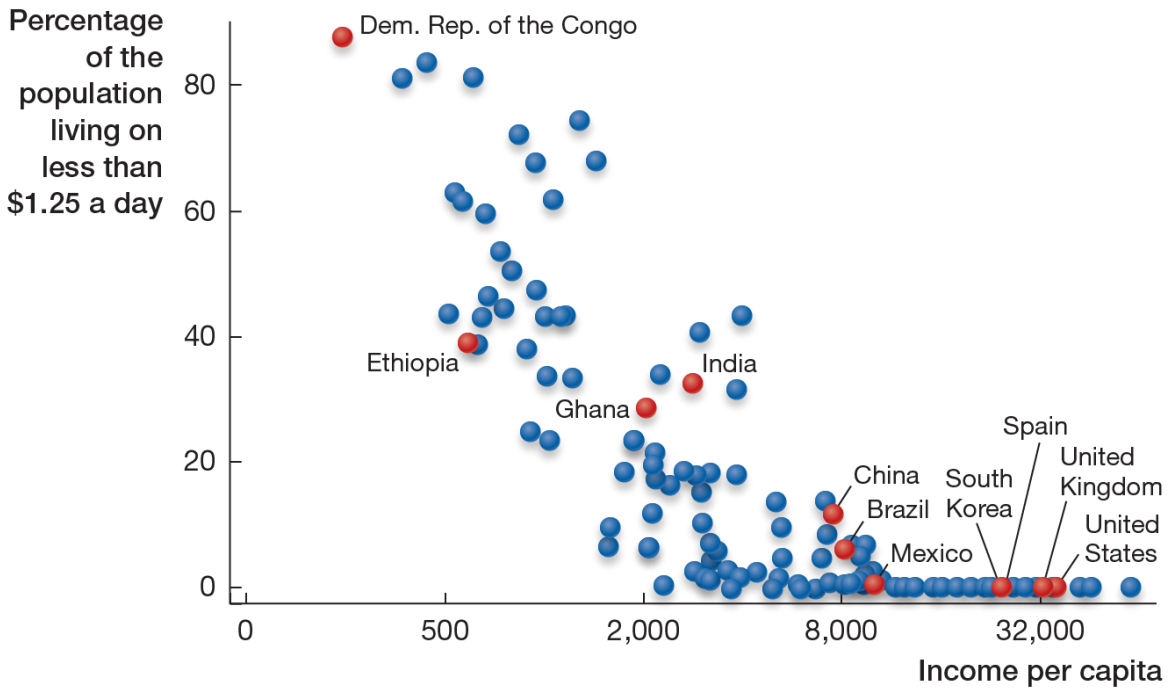


Source: OECD

There is a positive relationship between income per capita (and income per worker) and various measures of standard of living.

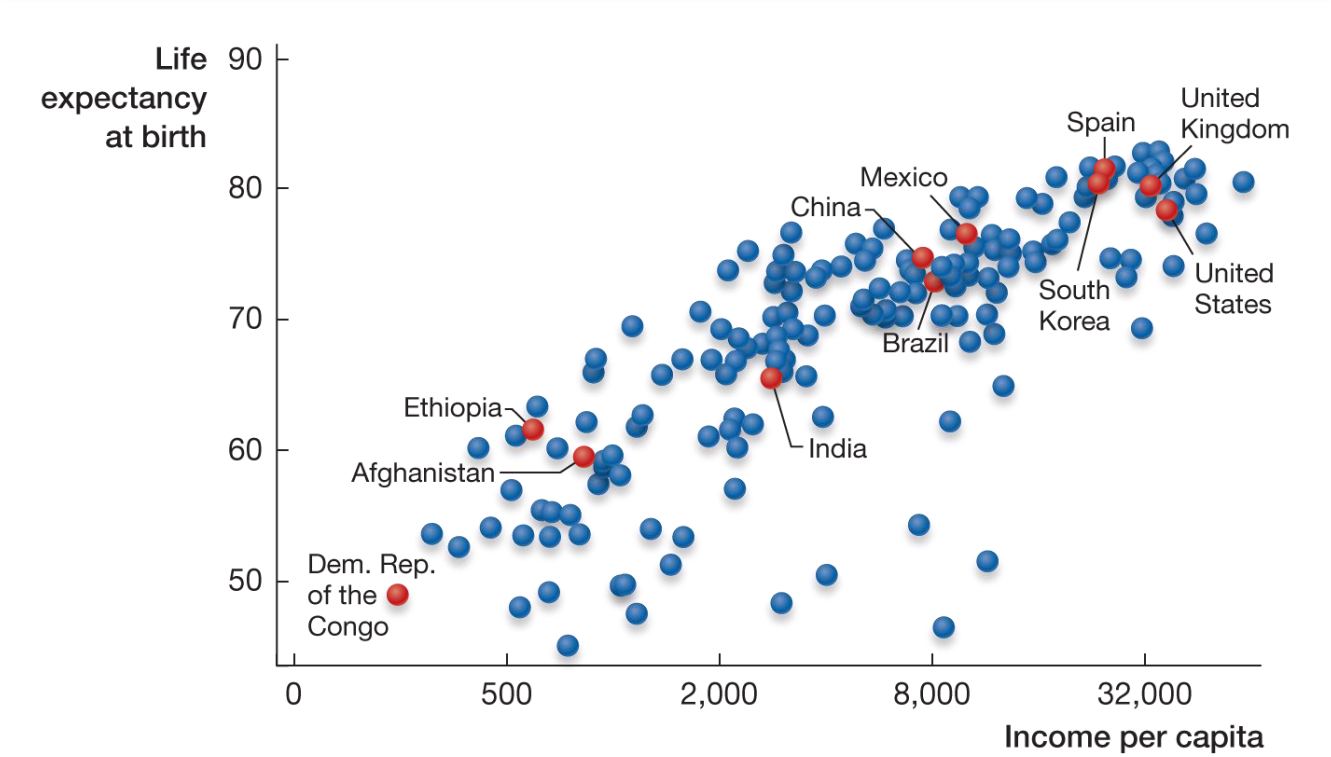
- Absolute poverty rates
- Life expectancy
- Human Development Index: combines information on income per capita, life expectancy, averages years of schooling and the enrollment of children in school

Poverty



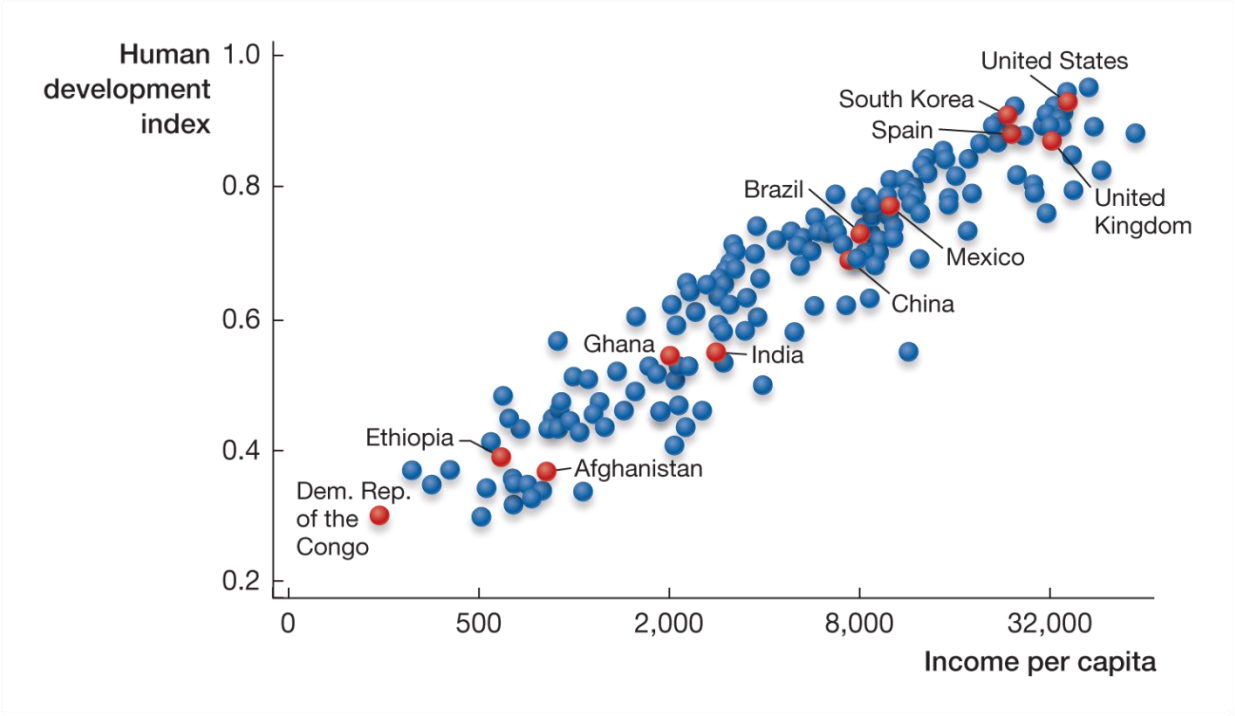
The Relationship Between Poverty and Income per Capita in 2010 (PPP-adjusted 2005 constant dollars)

Life expectancy



The Relationship Between Life Expectancy at Birth and Income per Capita in 2010 (PPP-adjusted 2005 constant dollars)

Human Development Index



The Relationship Between the Human Development Index and Income per Capita in 2010 (PPP-adjusted 2005 constant dollars)

Three sources for productivity differences:

1. Human capital - The stock of skills embodied in labor to produce output: $H = L \times h$

2. Physical capital - The stock of business structures (plants) and equipment (machines) used for production.

3. Technology/Efficiency

Aggregate Production Function

How exactly do increases in a factor of production lead to increases in productivity and GDP?

Macroeconomists use the aggregate production function to model the relationship between aggregate GDP and its factors of production.

Aggregate Production Function

The **aggregate production function** is:

$$Y = A \times F(K, H)$$

where

Y is GDP

K is the physical capital stock

H is the total efficiency units of labor

$F()$ is a mathematical function

A is an index of technology

Aggregate Production Function

The aggregate production function has the same two properties as the production function of an individual firm.

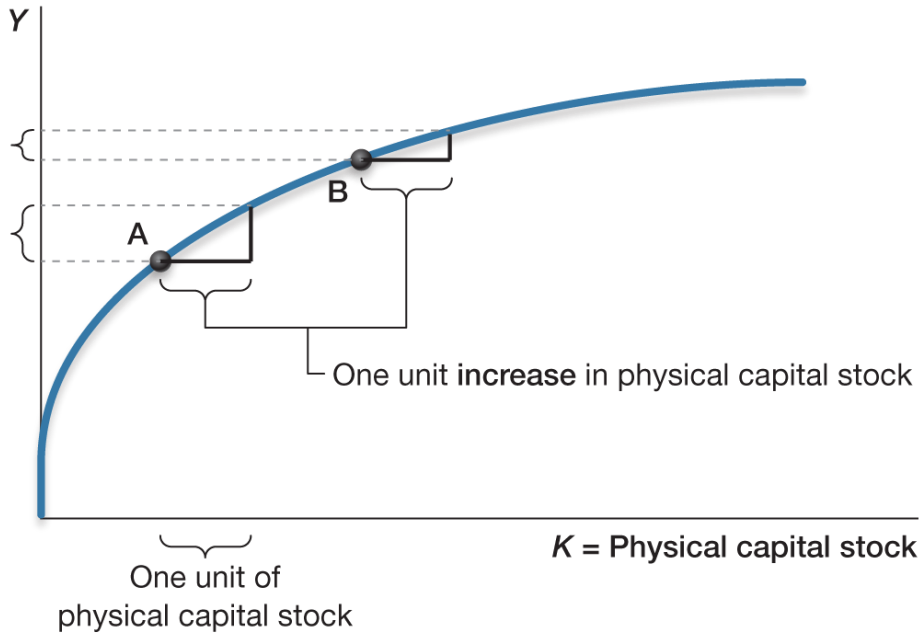
1. "More is better"

An increase in either physical capital or total efficiency units of labor, holding the other factor constant, leads to an increase in GDP.

2. Law of diminishing marginal product

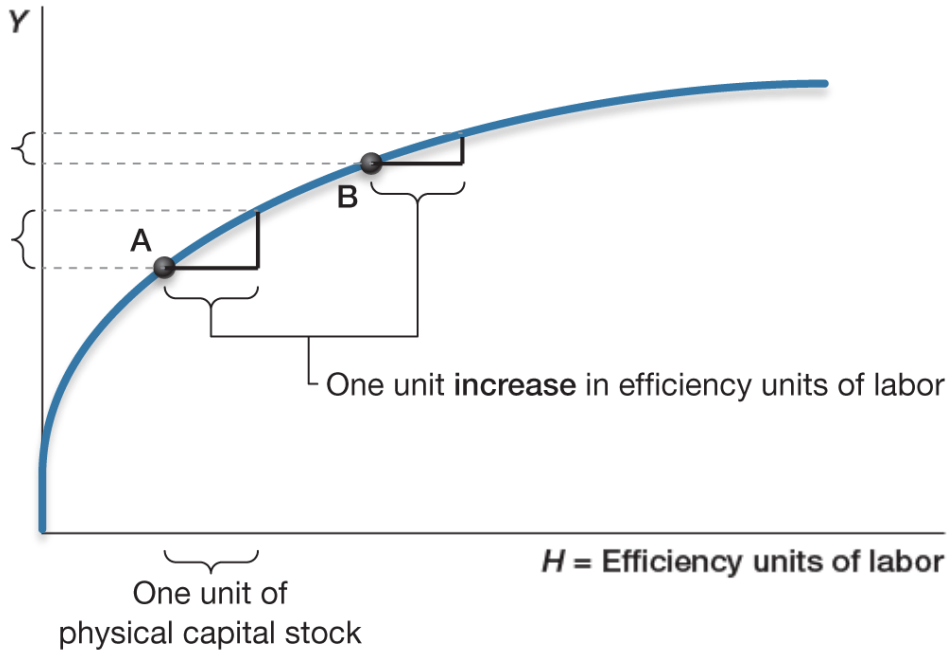
The *marginal* contribution of either physical capital or total efficiency units of labor to GDP diminishes when we increase the quantity used of that factor (holding all other factors of production constant).

Aggregate Production Function



The Aggregate Production Function with Physical Capital Stock on the Horizontal Axis (with the total efficiency units of labor held constant)

Aggregate Production Function



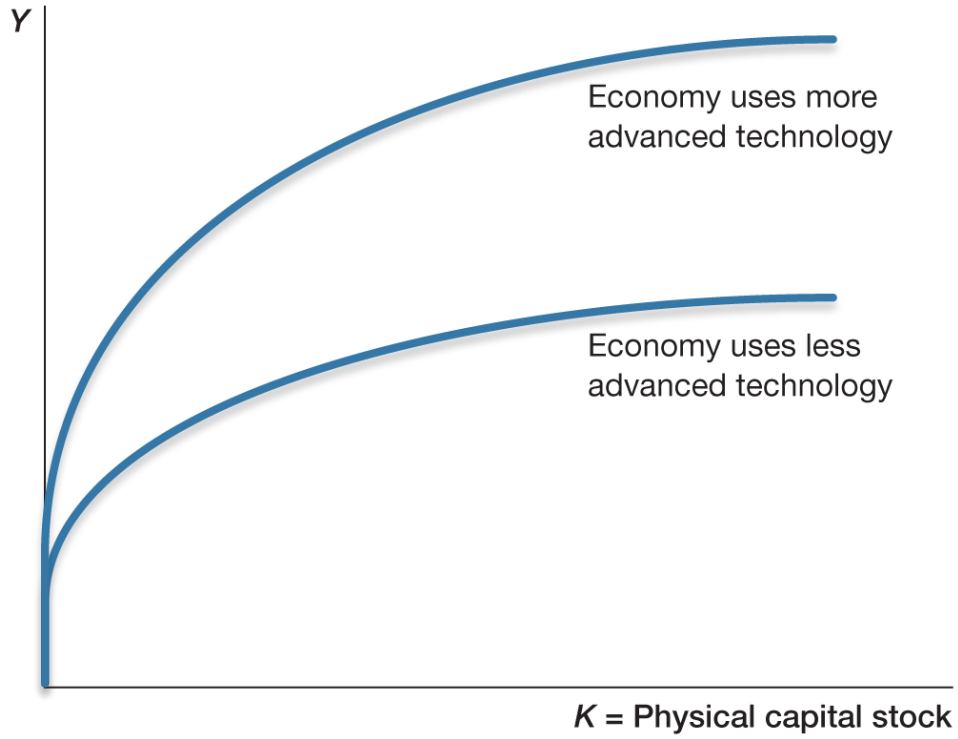
The Aggregate Production Function with the Efficiency Units of Labor on the Horizontal Axis (with physical capital stock held constant)

The Role and Determinants of Technology

With more advanced technology, more output can be produced with the same amount of physical capital and total efficiency units of labor.

Therefore, technology will shift the production function upward.

The Role and Determinants of Technology



The Shift in the Production Function Resulting from More Advanced Technology

Advances in technology result mostly from purposeful, optimizing decisions by entrepreneurs and firms.

Country	Number of Researchers	Researchers as a Percentage of the Labor Force	Research Spending ($ billions)	Research Spending as a Percentage of GDP
United States	1,334,628	0.89%	312.5	2.5
Japan	677,206	1.02%	118.0	3.0
Germany	268,100	0.61%	61.7	2.4
France	200,064	0.72%	40.4	2.1
Korea	179,812	0.76%	31.6	2.9
OECD Total	3,707,255	0.66%	740.5	2.1

Source: OECD Main Science and Technology Indicators database.

http://www.oecd.org/sti/msti.htm

Accounting for Productivity Differences

Country (1)	Income per Worker in 2010 (2)	Average Years of Schooling (3)	% of U.S. Physical Capital Stock per Worker in 2010 (4)	Income per Worker If Technology Were at U.S. Level (5)
United States	82,359	13.1	100.0	SAME
United Kingdom	67,025	9.8	65.8	61,548
South Korea	54,315	11.8	87.7	74,496
Spain	54,539	10.4	83.9	68,684
Mexico	27,625	9.1	33.5	47,725
Brazil	15,975	7.5	16.9	35,045
China	12,961	8.2	14.9	34,881
India	9,010	5.1	8.9	24,071
Ghana	4,928	7.1	4.2	21,502
Afghanistan	3,980	4.2	3.7	16,818
Dem. Rep. of the Congo	628	3.5	0.8	9,625

The last column is computed using the Cobb-Douglas production function:

$$Y = AK^{\frac{1}{3}}H^{\frac{2}{3}}$$