Lecture 2: Measuring the Macroeconomy

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ECON 101: Intermediate Macroeconomic Theory
Winter 2026

Today

1. How to measure aggregate economic activity
2. How to compare aggregate economic activity over time
3. How to compare aggregate economic activity across countries

Why measurement matters

GDP is used to summarize and compare economic performance.

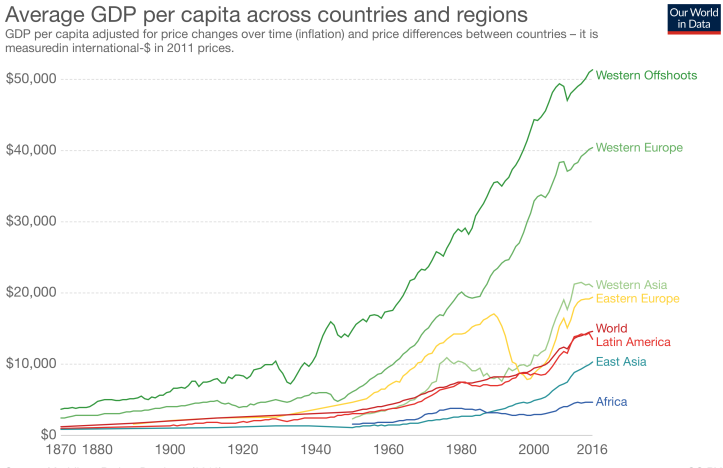
- Policymakers use GDP growth to judge whether the economy is strong or weak.
- GDP per capita is used to compare living standards across countries.

In both cases, conclusions depend on **how GDP is measured**:

- what counts as production,
- how prices are treated,
- and whether we adjust for population size or price differences.

Key question: When we say an economy is "doing well," what exactly are we measuring?

Last time


Average GDP per capita across countries and regions
GDP per capita adjusted for price changes over time (inflation) and price differences between countries – it is measuredin international-$ in 2011 prices.
Our World in Data
$50,000
$40,000
$30,000
$20,000
$10,000
$0
1870
1880
1900
1920
1940
1960
1980
2000
2016
Western Offshoots
Western Europe
Western Asia
Eastern Europe
World
Latin America
East Asia
Africa
Source: Maddison Project Database (2018)
CC BY
Note: These series are adjusted for price differences between countries using multiple benchmark years, and are therefore suitable for cross-country comparisons of income levels at different points in time.

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3. *goods and services* - tangibles and intangibles
4. *in an economy* - subject to boundaries
5. *certain period of time* - GDP is a flow, not a stock

Question: Why do we often report GDP "per capita"?

Measuring GDP: a naive approach

Goal: Measure the market value of what is produced in the economy.

Example economy:

$$\text{Steel sold for \$10} \rightarrow \text{Widget sold for \$15}$$

Naive idea: "Add up the value of production at each stage."

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Key idea: The *production approach* measures GDP as the sum of **value added**.

Three approaches to measuring GDP

GDP can be measured in three equivalent ways:

1. **Production approach**: sum *value added* across producers.
2. **Expenditure approach**: sum purchases of *final goods and services*.
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Plan: Compute GDP using the *production approach*, then verify that the other two give the same number.

Expenditure approach to measuring GDP

National income identity:

$$Y = C + I + G + NX$$

where

Y = GDP in dollars
C = consumption
I = investment (including inventories)
G = government purchases
NX = exports - imports (net exports)

Income approach to measuring GDP

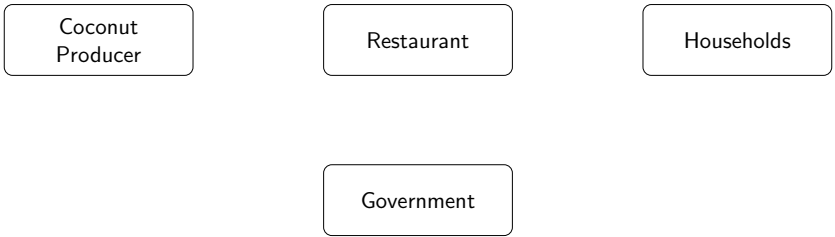
$$\mathrm{Y} = \mathrm{W} + \mathrm{NT} + \mathrm{NO} + \mathrm{D}$$

where

Y = GDP in dollars
W = employee compensation
NT = taxes less subsidies (net taxes)
NO = net operating surplus (*accounting* profits)
D = depreciation of fixed capital

The coconut economy: who interacts with whom?

Four agents: Coconut producer, Restaurant, Households, Government.



Step 0: Identify the agents.

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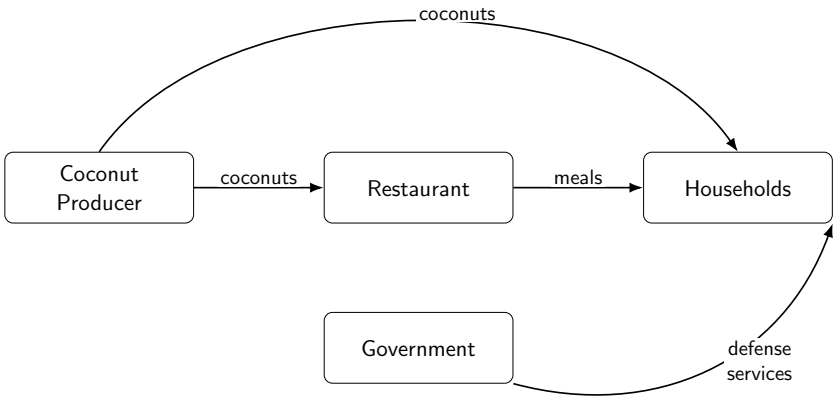

Step 1: Goods and services flows.

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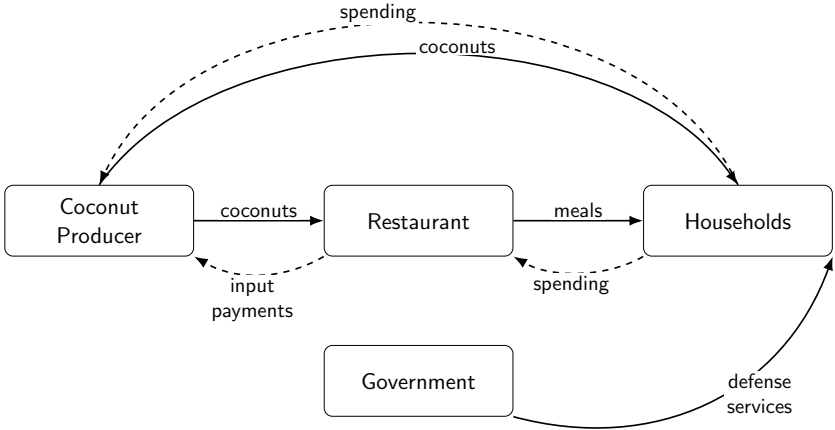

Step 2: Spending and input payments.

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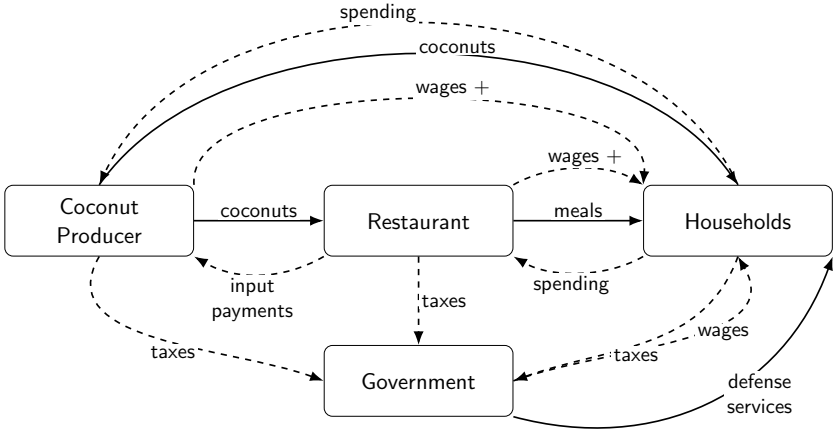

Step 3: Incomes (wages) and taxes.

The coconut economy: all economic flows

This diagram shows everything that happens in the economy.

There are three types of flows:

- **Goods and services** (solid arrows)
- **Spending and input payments** (dashed arrows)
- **Income and taxes** (dashed arrows)

Important: Not every arrow is used in every way of measuring GDP.

Next: Use the **production approach** as a filter, then verify with expenditure and income.

Production approach: what do we count?

Goal: Measure the value of goods and services *produced*.

Production approach uses:

- value of output produced by each agent
- minus intermediate inputs used in production

Production approach ignores (for now):

- how revenue is split into wages, profits, taxes
- who ultimately receives income

$$\textbf{Value added} = \text{output} - \text{intermediate inputs}$$

Coconut producer: economic activity

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Key takeaway

All those payments are important for the **income approach**, but for the **production approach** we will focus on output vs. inputs.

Coconut producer: production approach

Production approach: keep output and inputs; ignore how revenue is split.

- Value of output (coconuts): 20
- Intermediate inputs: 0

$$\boxed{\text{Value added} = 20 - 0 = 20}$$

Restaurant: production approach

From the diagram:

- Buys 6 million coconuts at \$2 each $\Rightarrow$ inputs $= 12$
- Sells meals to households $\Rightarrow$ revenue $= 30$

Production approach:

- Output (meals): 30
- Intermediate inputs (coconuts): 12

$$\boxed{\text{Value added} = 30 - 12 = 18}$$

For the income check later: wages $=4$, taxes $=3$, profits $=11$

Government: production approach

From the diagram:

- Provides defense services to households.
- No market price for these services.

How national accounts handle this:

- Government output is measured by cost.
- Relevant cost here: soldiers' wages $= 5.5$

$$\boxed{\text{Value added} = 5.5}$$

For the income check later: wages $=5.5$

GDP by the production approach

Value added by sector:

- Coconut producer: 20
- Restaurant: 18
- Government: 5.5

$$\text{GDP} = 20 + 18 + 5.5 = \boxed{43.5}$$

Interpretation: GDP is the total market value of final production, measured by summing value added.

Expenditure approach applied to the coconut economy

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Final expenditures:

- Households buy 4 million coconuts at \$2 $\Rightarrow$ \$8
- Households buy meals $\Rightarrow$ \$30
- Government buys defense services $\Rightarrow$ \$5.5

$$C = 8 + 30 = 38, \quad G = 5.5 \quad \Rightarrow \quad Y = \boxed{43.5}$$

Income approach applied to the coconut economy

Payments generated by production:

- Wages: $5 + 4 + 5.5 = 14.5$
- Profits: $13 + 11 = 24$
- Interest: 0.5
- Taxes on production: $1.5 + 3 = 4.5$

$$Y = 14.5 + (24 + 0.5) + 4.5 = \boxed{43.5}$$

The key identity

In the coconut economy, all three approaches give the same GDP.

$$\boxed{\text{Production} = \text{Expenditure} = \text{Income}}$$

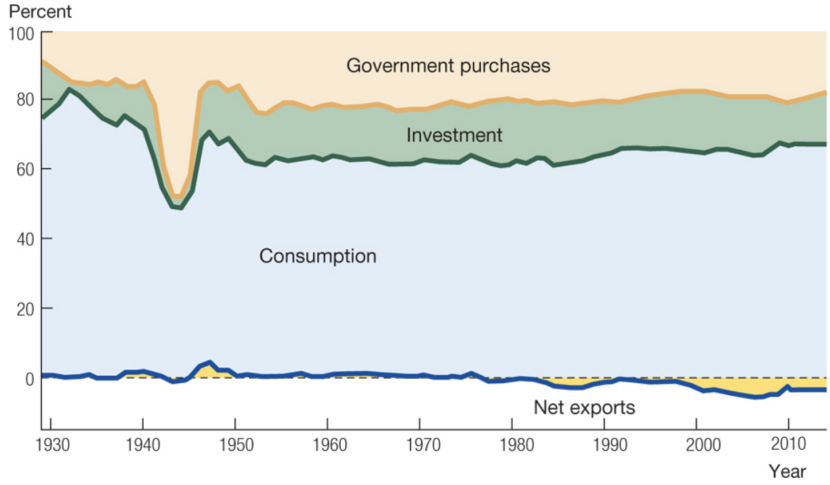
Interpretation:

- Everything produced is purchased by someone.
- Payments for production become income to someone.

This is accounting, not a theory.

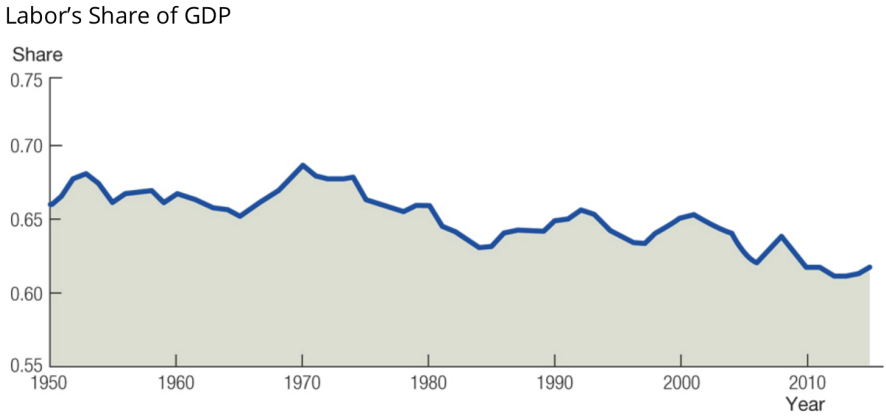
Trends in U.S. GDP components

Composition of U.S. GDP



Source: U.S. Department of Commerce, Bureau of Economic Analysis, www.bea.gov.

Labor's share of income



Source: U.S. Department of Commerce and author's calculations.

Examples of GDP accounting

How do the following appear in GDP?

1. You buy $100,000 of a stock and sell it a year later for $125,000.
2. Fears of a trade war lead businesses to stock a back-up inventory of $1 million goods from China.
3. To reduce inequality, the government raises $1 billion in taxes on the rich and transfers the proceeds to the poor.
4. You buy a friend's used car for $10,000. The original price of the car was $35,000.
5. A hurricane destroys 10% of the houses and the government spends $100 million to rebuild them.
6. $100 in apples are harvested and half are turned into cider and sold for $150.

Checkpoint

- GDP is an **accounting framework** for measuring production in an economy.
- We can measure it three ways (production, expenditure, income) — they agree by construction.
- Measurement choices matter most when we compare GDP **across time** and **across countries**.

Measuring GDP across time

Measuring GDP over time

GDP depends on both prices and quantities:

$$GDP = \sum_i P_i \times Q_i$$

This complicates comparisons over time since *both* prices and quantities change.

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Example: an *apples-and-oranges* economy:

$$GDP_t = \$1 \times 50 \text{ apples} + \$2 \times 30 \text{ oranges} = \$110$$
$$GDP_{t+1} = \$2 \times 55 \text{ apples} + \$2 \times 40 \text{ oranges} = \$190$$

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Question: How much of the \$80 is "more production" vs. "higher prices"?

Measuring GDP over time: the index-number problem

Challenge: Separating price and quantity changes is not automatic.

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Three popular approaches:

1. *Laspeyres index* uses **initial** prices
2. *Paasche index* uses **final** prices
3. *Chain-weighted index* combines both (a compromise)

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Question: Why not just add up quantities and ignore prices?

Example GDP calculations: Laspeyres

The *Laspeyres index* evaluates GDP at initial prices:

$$GDP_t^L = \$1 \times 50 \text{ apples} + \$2 \times 30 \text{ oranges} = \$110$$
$$GDP_{t+1}^L = \$1 \times 55 \text{ apples} + \$2 \times 40 \text{ oranges} = \$135$$

$$\Delta GDP_t^L = \$25 \qquad PC_t^L = \frac{25}{110} = 22.7\%$$

Example GDP calculations: Paasche

The *Paasche index* evaluates GDP at final prices:

$$GDP_t^P = \$2 \times 50 \text{ apples} + \$2 \times 30 \text{ oranges} = \$160$$
$$GDP_{t+1}^P = \$2 \times 55 \text{ apples} + \$2 \times 40 \text{ oranges} = \$190$$

$$\Delta GDP_t^P = \$30 \qquad PC_t^P = \frac{30}{160} = 18.8\%$$

Example GDP calculations: chain-weighted

The *chain-weighted index* is a geometric average:

$$\begin{aligned} PC_t^{chain} &= \left[(1 + PC_t^P)(1 + PC_t^L)\right]^{1/2} - 1 \\ &= (1.188 \times 1.227)^{1/2} - 1 \\ &= 20.7\% \end{aligned}$$

Important point:

- There is no single "true" way to aggregate apples and oranges into one number.
- Different index formulas answer slightly different questions.

Real versus nominal GDP

When GDP is calculated using contemporaneous prices we call it **nominal GDP**.

When GDP is calculated holding prices fixed (via an index) we call it **real GDP**.

- Laspeyres, Paasche, and chain-weighted are all **real GDP** constructions.

$$\textbf{Nominal GDP} = \text{Price level} \times \text{Real GDP} \qquad \Rightarrow \qquad \textbf{GDP deflator} = \frac{\text{Nominal GDP}}{\text{Real GDP}}$$

A practical complication: quality changes and new goods

Our apples-and-oranges example is simple because apples and oranges are (mostly) the same goods over time.

But many goods change quality:

- Cars become safer and more fuel-efficient.
- Smartphones add new features and improve performance.

Measurement challenge:

- If the price rises, is that *inflation* or *higher quality*?
- What if the year $t+1$ product did not exist in year t?

Big idea: Real-world indices require decisions about **quality adjustment** and **new goods**.

Measuring GDP across space

Comparing GDP across countries

Cross-country comparisons are complicated by:

- Currency denominations (exchange rates)
- Different price levels (a dollar buys different baskets)

Solution: compare GDP using a common reference basket and price level (**PPP**).

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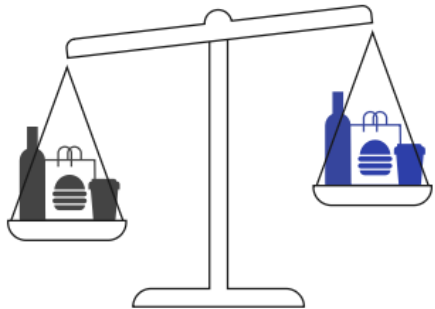
Question: What issues remain even after PPP adjustment?

PPP intuition: the Big Mac index

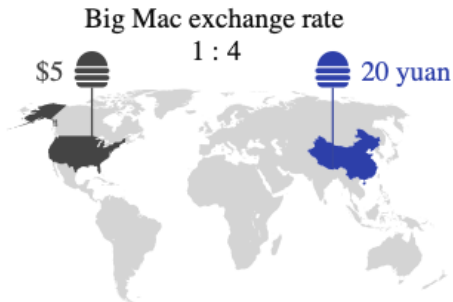
Purchasing-power parity implies that exchange rates are determined by the value of goods that currencies can buy



Step 1: PPP says exchange rates should equalize purchasing power across countries.

PPP intuition: the Big Mac index

Differences in local prices – in our case, for Big Macs – can suggest what the exchange rate should be



Step 2: Use a common product (Big Mac) to infer an implied PPP exchange rate.

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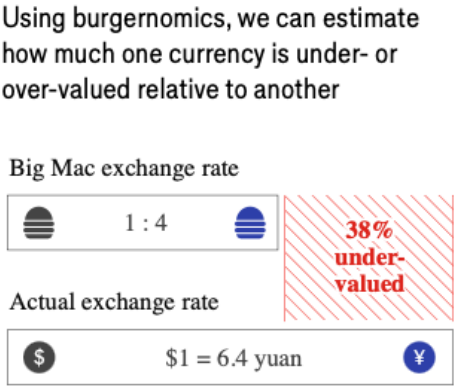

Step 3: Compare implied vs. actual exchange rates to describe under/over-valuation relative to PPP.

Example: cross-country GDP comparisons

To compare U.S. and China GDP, convert the latter to U.S. dollars at a common price level:

$$\begin{aligned} GDP_{USD}^{China} &= \frac{P^{USA}}{P^{China}} \times GDP_{Nominal}^{China} \\ &= P^{USA} \times \frac{GDP_{Nominal}^{China}}{P^{China}} \\ &= P^{USA} \times GDP_{Real}^{China} \end{aligned}$$

- GDP_{USD}^{China} measures China's GDP at U.S. price levels.
- The price ratio captures both exchange rates and relative prices.

Back to the big picture: what does GDP per capita compare?

Recall the cross-country GDP per capita figure from last time.

That figure is meaningful only after two adjustments:

1. **Over time:** adjust for inflation $\Rightarrow$ real GDP
2. **Across countries:** adjust for price levels $\Rightarrow$ PPP (common prices)

Takeaway: Comparisons require measurement choices. Those choices affect conclusions.

What GDP does *and does not* tell us

What GDP does not include (by construction):

- Home production and unpaid work
- Non-market services (e.g. household care)
- Health, life expectancy, or well-being
- Crime, safety, and social cohesion
- Environmental quality and degradation
- Free digital goods (apps, social media)

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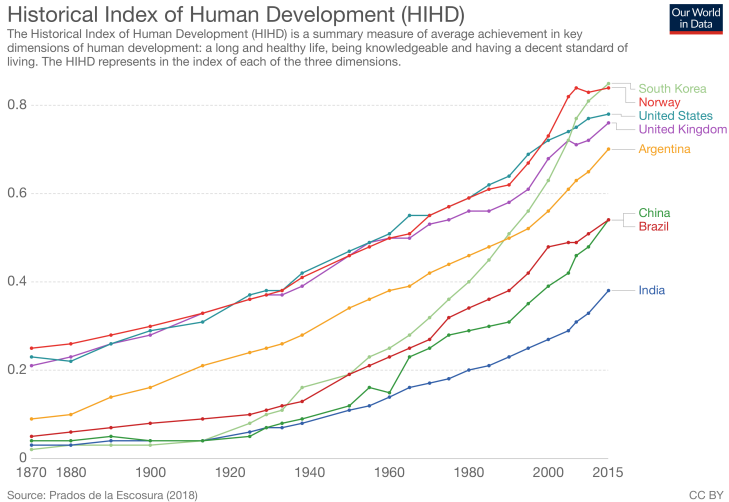
Takeaway: GDP is a measure of **aggregate economic activity**, not a measure of **living standards or fairness**.

Human Development Index



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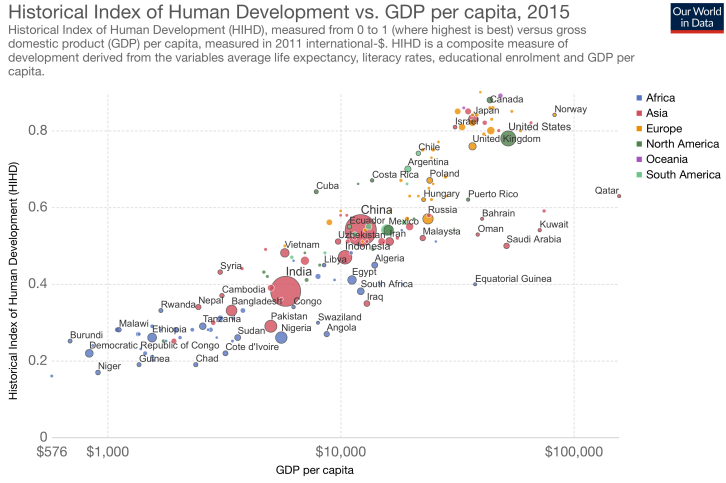

Source: Prados de la Escosura (2018); Maddison Project Database (2018)

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A Model of Production