

ECON B225: ECONOMIC DEVELOPMENT

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Administrative Matters

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- **Problem Set will be available on Moodle by Monday.**

Measuring Development

Agenda

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- **Determining who is and isn't "poor"**
- **How to make cross-country wealth comparisons**
- **Other measures of poverty**
- **Health and Education Measures**
- **Poverty Indexes**
- **Brief review of the Gini Coefficient**
- **Broad Growth Trends Over Time**

Motivating Questions

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- **How do we decide someone is poor?**
- **What is poverty?**
- **How do we know or decide the poverty level of a country or some aggregate unit above an individual?**

- **Challenge because of the multidimensional nature of poverty**
 - ▣ Income
 - ▣ Health
 - ▣ Education
 - ▣ Access to food/Food security
 - ▣ Access to opportunities/freedom (Amartya Sen)
 - ▣ Many others...

- **Economists' approach is to measure material well being by looking at one's ability to consume. The measurement they use for this is income**

Economists' Approach

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Individual ID	Annual Value of Production (Income)	Income per Day
1	100,000	273.97
2	55,000	150.68
3	120,000	326.77
4	500	1.37
5	693.5	1.90

- Economists look at income microdata for individuals
- We need some threshold for material well being
- What should be our threshold?

Economists' Approach

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Individual ID	Annual Value of Production (Income)	Income per Day
1	100,000	273.97
2	55,000	150.68
3	120,000	326.77
4	500	1.37
5	693.5	1.90

- **A common threshold that researchers and policymakers have decided something close to 2.00 USD/day**
 - ▣ People below this are “poor” in a material sense
 - ▣ People above are “not poor”

Economists' Approach

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Individual ID	Annual Value of Production (Income)	Income per Day
1	100,000	273.97
2	55,000	150.68
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□ **Easy! That means Individuals 4 and 5 are considered “poor”**



A Note on the 2 USD/Day Threshold

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- **Actually 1.9 USD per day is the more common measure used by international institutions interested in measuring this**
 - ▣ I'm just rounding up to 2
- **Also, different countries have different thresholds**
 - ▣ It's important not to use “national” poverty thresholds when comparing across countries
 - Better to use internationally agreed on criteria like 1.9 USD per day

Economists' Approach

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Individual ID	Annual Value of Production (Income)	Income per Day	Poor Indicator (0 = Not Poor, 1 = Poor)
1	100,000	273.97	0
2	55,000	150.68	0
3	120,000	326.77	0
4	500	1.37	1
5	693.5	1.90	1

- **But, what if people come from different regions of the world and we want to compare them?**
- **Is it fair to compare incomes in New York City to incomes in Lomé, Togo?**
 - ▣ Can the same income purchase the same amount in both NYC and Harrisburg?

Local Prices Pose Challenges

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- **Of course prices are higher in NYC than Harrisburg, resulting in a higher cost of living**
 - ▣ Given a certain level of consumption, it takes more money to achieve that level in NYC compared to Harrisburg
- **This means that raw income, without accounting for the prices an individual is facing will distort who we count as “poor” and “not poor”**
- **Remember: Income is trying to measure how much someone is able to consume. Prices are an important component in this**

Solution: Adjust for Purchasing Power Parity (PPP)

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- **Adjusting for PPP makes it clear how much a certain person's income can purchase in the place where they live**
- **Example:**
 - ▣ In NYC, 1 USD can buy a bundle of x , y , and z goods
 - ▣ In Harrisburg that same bundle costs 0.5 USD
 - ▣ This means that a person in Harrisburg only needs half the income someone in NYC needs to consume the same amount of x , y and z as the person in NYC!
 - ▣ So a person in Harrisburg with 0.5 USD has the same income (adjusted for PPP) as a person in NYC with 1 USD
 - Although their unadjusted incomes differ

International Context and the “Conversion Factor”

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- **Let's do an example in the international context**
- **Consider the simple example of an individual in the US with 120 USD of income, and an individual in Lomé, Togo with 110 USD of income**
 - ▣ Without adjusting for PPP, who is poorer?
- **Let's say that in Lomé, Togo it takes the equivalent of 0.833 USD to purchase what would be 1 USD worth of commonly consumed goods in the US**
 - ▣ How do we use this to adjust these incomes for PPP?

International Context and the “Conversion Factor”

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- **Let’s say that in Lomé, Togo it takes the equivalent of 0.833 USD to purchase what would be 1 USD worth of goods in the US**
 - ▣ How do we use this to adjust these incomes for PPP?
- **Recipe: Need to adjust one person’s income for the prices faced by the other**
 - ▣ Compute the conversion factor: $\frac{1}{0.833} = 1.2$
 - This is a measure of the purchasing power of 1 USD facing Togo prices compared to 1 USD facing US prices
 - ▣ Multiply the income of the person in Lomé by the conversion factor: $1.2 \times 110 = 132 \text{ USD}$
 - ▣ So the income for the person in Lomé adjusted for PPP is 132. The income for the person in the US is 120 USD
 - No adjustment is necessary for the US person in this construction
 - ▣ Our conclusion over who is poorer has changed!

Economists Approach

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Individual ID	Annual Value of Production (Income)	Income per Day	Poor Indicator (0 = Not Poor, 1 = Poor)	Country Indicator (0=US, 1 = Togo)	Income per Day (PPP)
1	100,000	273.97	0	1	328.764
2	55,000	150.68	0	1	180.816
3	120,000	326.77	0	0	326.77
4	500	1.37	1	1	1.644
5	693.5	1.90	1	1	2.28

□ **Now, only individual 4 is poor when adjusting for PPP**

□ Also, note the richest person in the dataset changed when you adjust for PPP

PPP Conclusions

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- PPP adjustments can really alter assessments of who is poor and who is not
- Whenever you are making comparisons between people or countries based on income and wealth, you should use measurements adjusted for PPP
 - ▣ You always want PPP-adjusted data series available from the World Bank and IMF if you use them in the future

Making Statements About Countries or other Aggregate Units

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Individual ID	Annual Value of Production (Income)	Income per Day	Poor Indicator (0 = Not Poor, 1 = Poor)	0=US, 1 = Togo	Income per Day (PPP)	Poor Indicator (PPP Adjusted)
1	100,000	273.97	0	1	328.764	0
2	55,000	150.68	0	1	180.816	0
4	500	1.37	1	1	1.644	1
5	693.5	1.90	1	1	2.28	0

- I've deleted the one US person in the dataset to consider Togo all on its own
- Assume for the exercise, these four people are representative of all of Togo
- How can we use this information to assess the wealth of this country?
 - Any good ideas?

Making Statements About Countries or other Aggregate Units

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4	500	1.37	1	1	1.644	1
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- Let's find the average income per person. This is just GDP per capita!
- Expressed formally as:

$$\frac{\sum_i^{N_c} Income_i}{N_c} = GDP_c$$

- Or adjusting for PPP

$$\frac{CF_c \times \sum_i^{N_c} Income_i}{N_c} = GDP_c (PPP)$$

**CF for
conversion
factor**

Making Statements About Countries or other Aggregate Units

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Individual ID	Annual Value of Production (Income)	Income per Day	Poor Indicator (0 = Not Poor, 1 = Poor)	Country Indicator (0=US, 1 = Togo)	Income per Day (PPP)	Poor Indicator (PPP Adjusted)
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2	55,000	150.68	0	1	180.816	0
4	500	1.37	1	1	1.644	1
5	693.5	1.90	1	1	2.28	0
Total Income	156,193.5					

- Let's find the average income per person. This is just GDP per capita!
- Expressed formally as:

$$\frac{\sum_i^{N_c} Income_i}{N_c} = GDP_c$$

- Or adjusting for PPP

$$\frac{CF \times \sum_i^{N_c} Income_i}{N_c} = GDP_c (PPP)$$

GDP per Capita (PPP) Example

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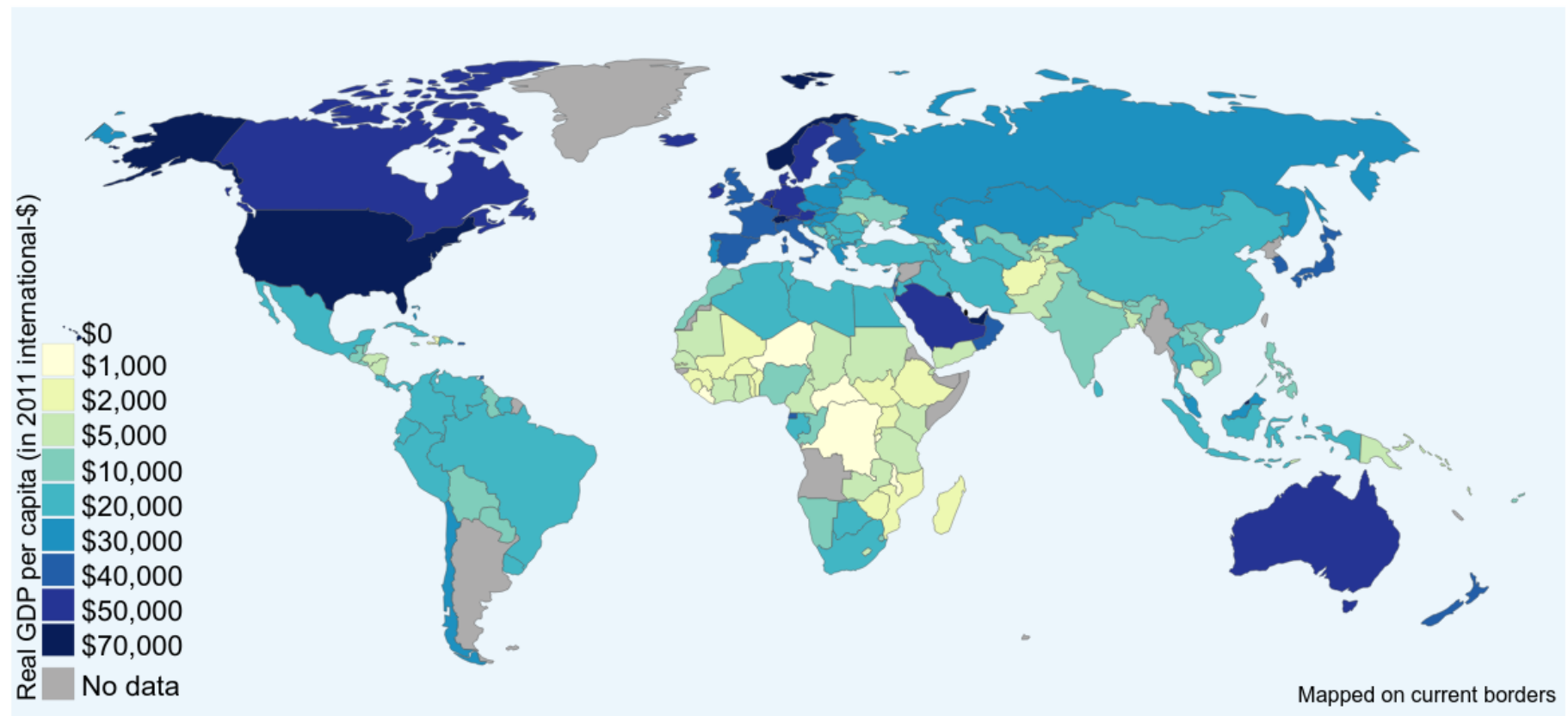
$$\frac{CF_c \times \sum_i^{N_c} Income_i}{N_c} = GDP_c(PPP) \quad (1)$$

$$\Rightarrow \frac{1.2 \times 156,193.5}{4} = \frac{187,432.2}{4} = 46,858.05 \quad (2)$$

- **How is this country doing? The US's GDP per capita is over 70,000 USD**
 - ▣ So compared to a known wealthy country, this country is pretty rich
 - ▣ These data was made up for illustrative purposes. In reality Togo is between 1,000 USD and 2,000 USD per day (PPP)

World Bank data: GDP per capita, 2014

GDP per capita is adjusted for price changes over time and between countries. It is expressed in 2011 international dollars. Since some observations for 2014 are not available the map displays the closest available data (2013 to 2014).



Data source: GDP per capita PPP 2011 – WDI

OurWorldInData.org/economic-growth • CC BY-SA

GDP per Capita (PPP) Example

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$$\frac{CF_c \times \sum_i^{N_c} Income_i}{N_c} = GDP_c (PPP) \quad (3)$$

$$\Rightarrow \frac{1.2 \times 156,193.5}{4} = \frac{187,432.2}{4} = 46,858.05 \quad (4)$$

□ But what does this cover up?

- The fact that 1/4 of the people in the country are poor! That's a large share of the population

Metric to Cover the Extent of Poverty in a Country

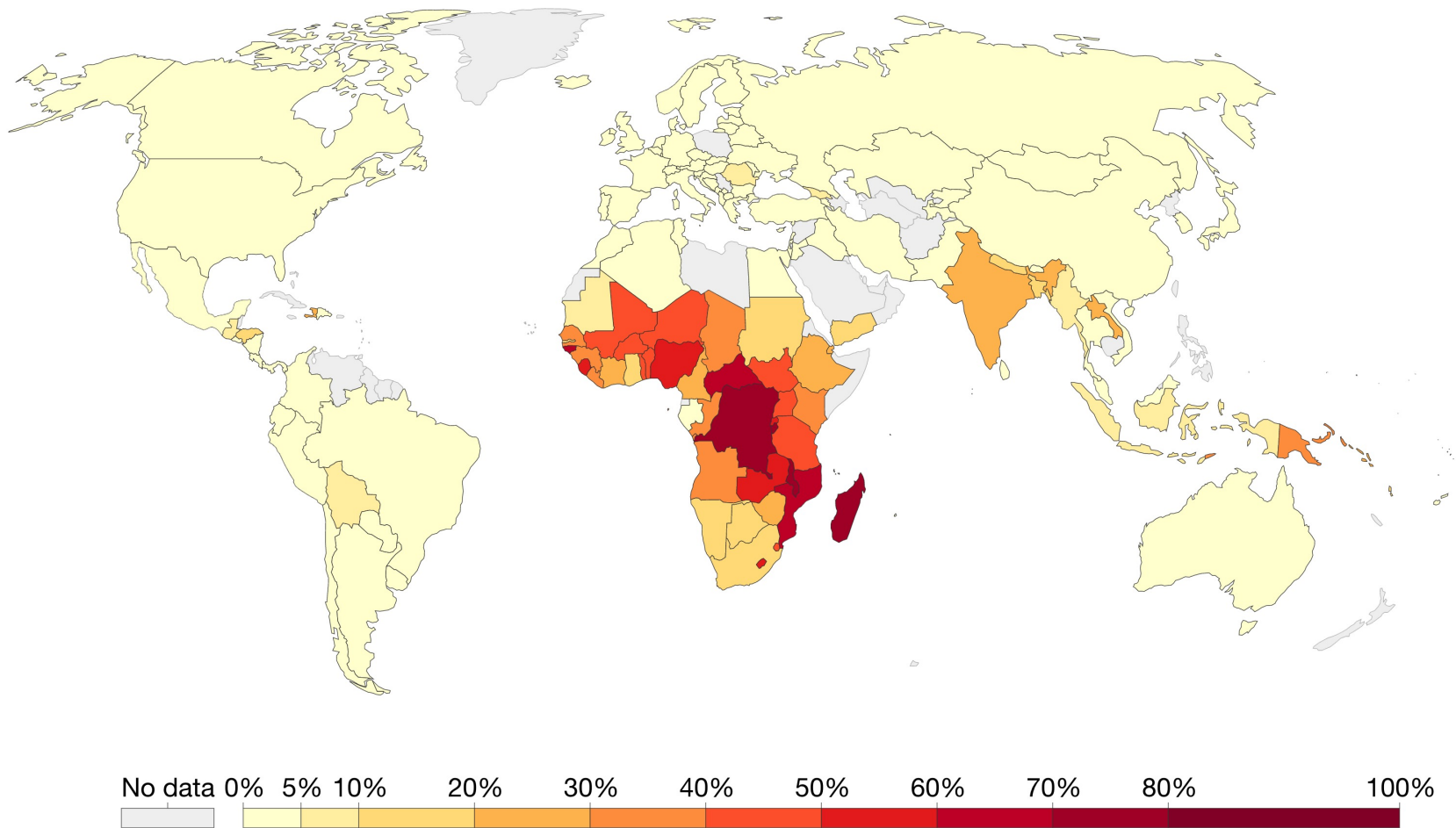
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- So we need a metric to measure how prevalent poverty is in a country
- For this, we use the poverty rate or “Headcount Ratio”
- The Headcount Ratio is just the percentage of the population that’s classified as poor, or

$$HC_c = \frac{\text{Number of Poor}_c}{N_c} \quad (5)$$

Share of the population living in extreme poverty, 2014

The share of individuals living below the 'International Poverty Line' of \$1.90 per day.



Source: World Bank

OurWorldInData.org/extreme-poverty/ • CC BY

Note: Depending on the country and year, the poverty rate relates to either income or consumption. Figures are given in international-\$. This means they are adjusted for price differences between countries and adjusted for inflation to allow comparisons between countries and over time. Income/consumption is measured at the household level, and is assumed to be divided equally among all household members.

Limitations of the Headcount Ratio

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Country 1	
Ind. ID	Income per Day (PPP)
1	300
2	300
3	300
4	1.8
5	1.8

Country 2	
Ind. ID	Income per Day (PPP)
1	300.833
2	300.833
3	300.833
4	0.05
5	0.05

- What is each country's respective GDP per capita (PPP) and Headcount Ratio?
 - ▣ GDP per capita: 65,962.8 USD
 - ▣ Headcount Ratios: 40%
- But would you say these two countries have the same poverty levels?

Limitations of the Headcount Ratio

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Country 1	
Ind. ID	Income per Day (PPP)
1	300
2	300
3	300
4	1.8
5	1.8

Country 2	
Ind. ID	Income per Day (PPP)
1	300.833
2	300.833
3	300.833
4	0.05
5	0.05

- What are these two metrics (GDP per capita and the Headcount ratio) not capturing
 - ▣ The depth of the poverty in the two countries

Measuring the Depth of Poverty: The Poverty Gap

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- The Poverty Gap measures the depth of poverty in a country
- It is the total amount of daily income it would take to bring all the poor people in a country up to the poverty threshold, or formally:

$$PG_c = \sum_{i=1}^{H_c} (\bar{Y} - Y_i) \quad (6)$$

Diagram illustrating the components of the Poverty Gap formula:

- H_c : Number of people below $\bar{Y}$
- $\bar{Y}$: Poverty Threshold
- Y_i : Income of Individual i

Calculating the PG for Country 1

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Country 1	
Ind. ID	Income per Day (PPP)
1	300
2	300
3	300
4	1.8
5	1.8

- Using a 2 USD per day threshold:

$$\begin{aligned} PG_1 &= \sum_{i=1}^{H_1} (\bar{Y} - Y_i) \\ &= (2 - 1.8) + (2 - 1.8) \\ &= 0.4 \end{aligned}$$

Calculating the PG for Country 2

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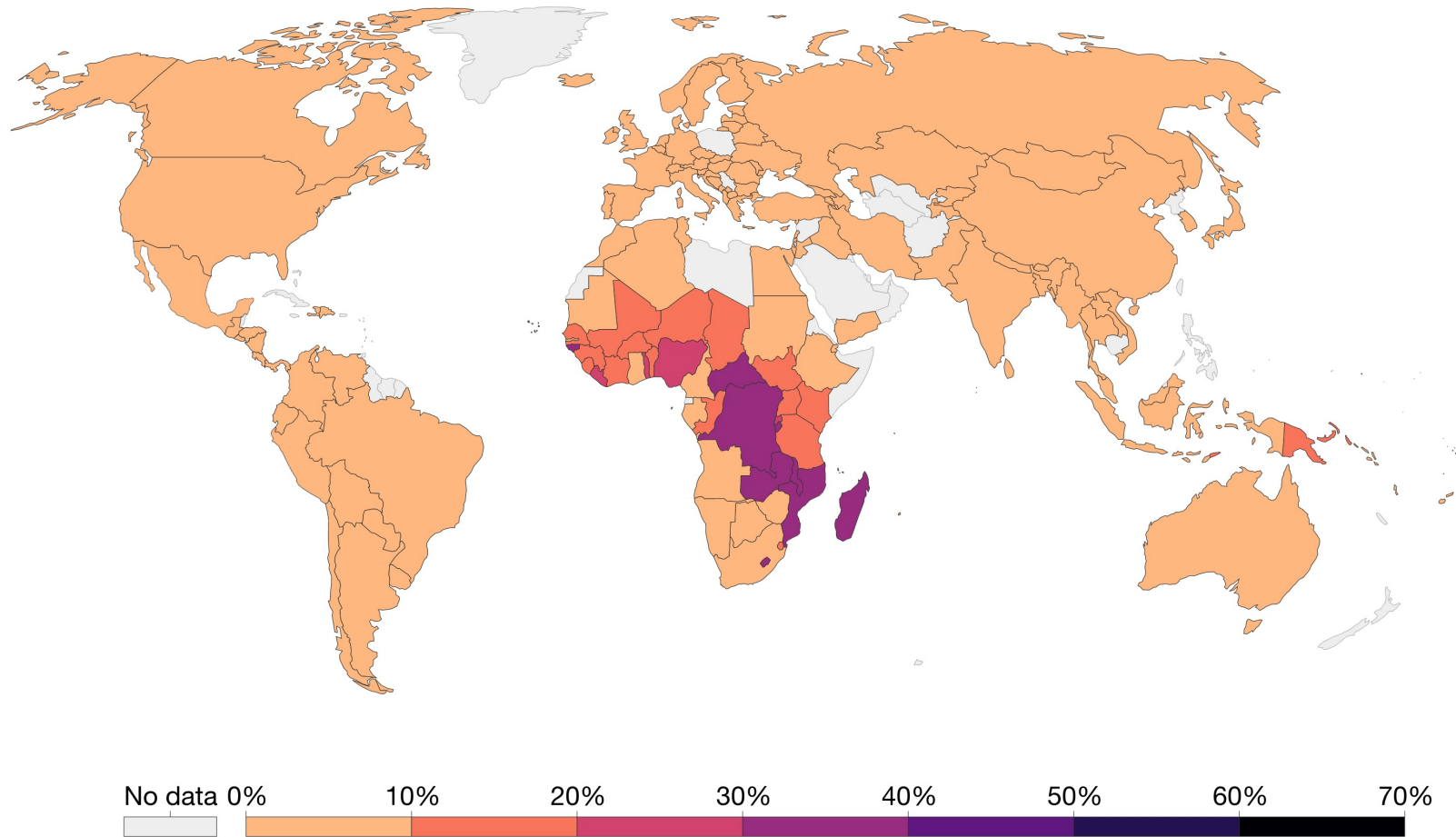
Country 2	
Ind. ID	Income per Day (PPP)
1	300.833
2	300.833
3	300.833
4	0.05
5	0.05

□ Using a 2 USD per day threshold:

$$\begin{aligned} PG_2 &= \sum_{i=1}^{H_2} (\bar{Y} - Y_i) \\ &= (2 - 0.05) + (2 - 0.05) \\ &= 3.9 \end{aligned}$$

Poverty gap index at 1.90 int-\$ per day, 2010

The poverty gap index is the mean shortfall in income or consumption from the International Poverty Line (\$1.90 a day in 2011 international dollars) counting the non-poor as having zero shortfall, expressed as a percentage of the poverty line. International dollars are adjusted for inflation over time and for price differences between countries.



Source: World Bank

OurWorldInData.org/extreme-poverty/ • CC BY

The Average Poverty Gap

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- It might be useful to know the answer to the question: How much would the average non-poor person need to transfer to the poor to bring everyone out of poverty?
 - ▣ Answer: The Average Poverty Gap (APG)

$$APG_c = \frac{PG_c}{NonPoorPop_c} \quad (7)$$

Thinking Beyond Income Question

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- **Let's say you graduate and go to work in a low-income country and you work at local income levels**
 - ▣ <2 USD per Day PPP
- **Are you “poor”?**
- **By these definitions yes, BUT**
 - ▣ You'd have a BA from Bryn Mawr and all the opportunities that opens up
 - ▣ You'd have access to some of the best medical care in the world
 - ▣ Educational and professional opportunities from your professional experience

So There are other Dimensions to Poverty than Material Wealth

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- **Many of these are measurable**
- **Common to look at the average educational level of the population:**
 - ▣ Percent of Adults Literate or Math Literate
 - ▣ Average grade completed
 - ▣ Percent of Adults completed secondary school
 - ▣ Percent of age-appropriate children enrolled in primary school or secondary school

Health Measures

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□ Common Health Measures

- Life expectancy at birth in years
- Percent of population malnourished
- Child mortality, usually measured as follows

$$\text{Infant Mortality}_c = \frac{\text{Deaths of Children} < 5 \text{ years old}_c}{1,000 \text{ Live Births}_c} \quad (8)$$

- How are these measures different from one another? How are they the same?

Too Much Focus on Income?

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- **Some countries don't perform well in terms of income, but do well with health measures (Cuba's an example of this)**
- **Given that being poor has so many dimensions (material, education, health, etc.) why not try to boil all this down into an index?**
 - ▣ This is one measure that incorporates all of these dimensions
 - ▣ So Cuba would perform better in this measure
- **Many different “poverty indexes”**

Example of a Poverty Index

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□ The UN Human Development Index (HDI)

- ▣ Ranges from 0 to 1, 0 is the poorest, 1 is the richest
- ▣ Considers three main dimensions measured by three separate indexes:
 1. Longevity, measured in life expectancy (denoted *Long* below)
 2. Knowledge, measured in mean years of schooling and expected years of schooling (denoted *Know* below)
 3. Standard of living, GDP per capita (denoted *Liv* below)

$$HDI_c = f(Long_c, Know_c, Liv_c) = \frac{1}{3}(Long_c + Know_c + Liv_c) \quad (9)$$

Example of Poverty Index

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- ***Liv*** is constructed as follows,

$$Liv_c = \frac{\ln(x_1) - \ln(100)}{\ln(\bar{Y}) - \ln(100)} \quad (10)$$

Annual GDP per Capita

Some benchmark for “developed” (75,000 USD for example)

- ***Long*** is constructed as follows,

$$Long_c = \frac{x_2 - 20}{85 - 20} \quad (11)$$

Life expectancy at birth

- ***Know*** is constructed as follows,

$$Know_c = \frac{1}{2} \left(\frac{x_3}{15} + \frac{x_4}{18} \right) \quad (12)$$

Mean Years of Schooling

Expected years of schooling

This seems great right!?

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- **Clear advantage in it expresses a multidimensional measure that is a function of health, education, and income**
 - ▣ Offers some complexity and nuance when making comparisons between countries
- **In practice, actually limited value for economists**
 - ▣ As an index it has no units attached, so interpretation outside of simple comparisons is hard
 - ▣ The separate measures are fine! Why lose all that nuance?
 - It's not so hard to look at two or more measures at once
 - ▣ Very rarely used in academic papers

Consider Cuba Again

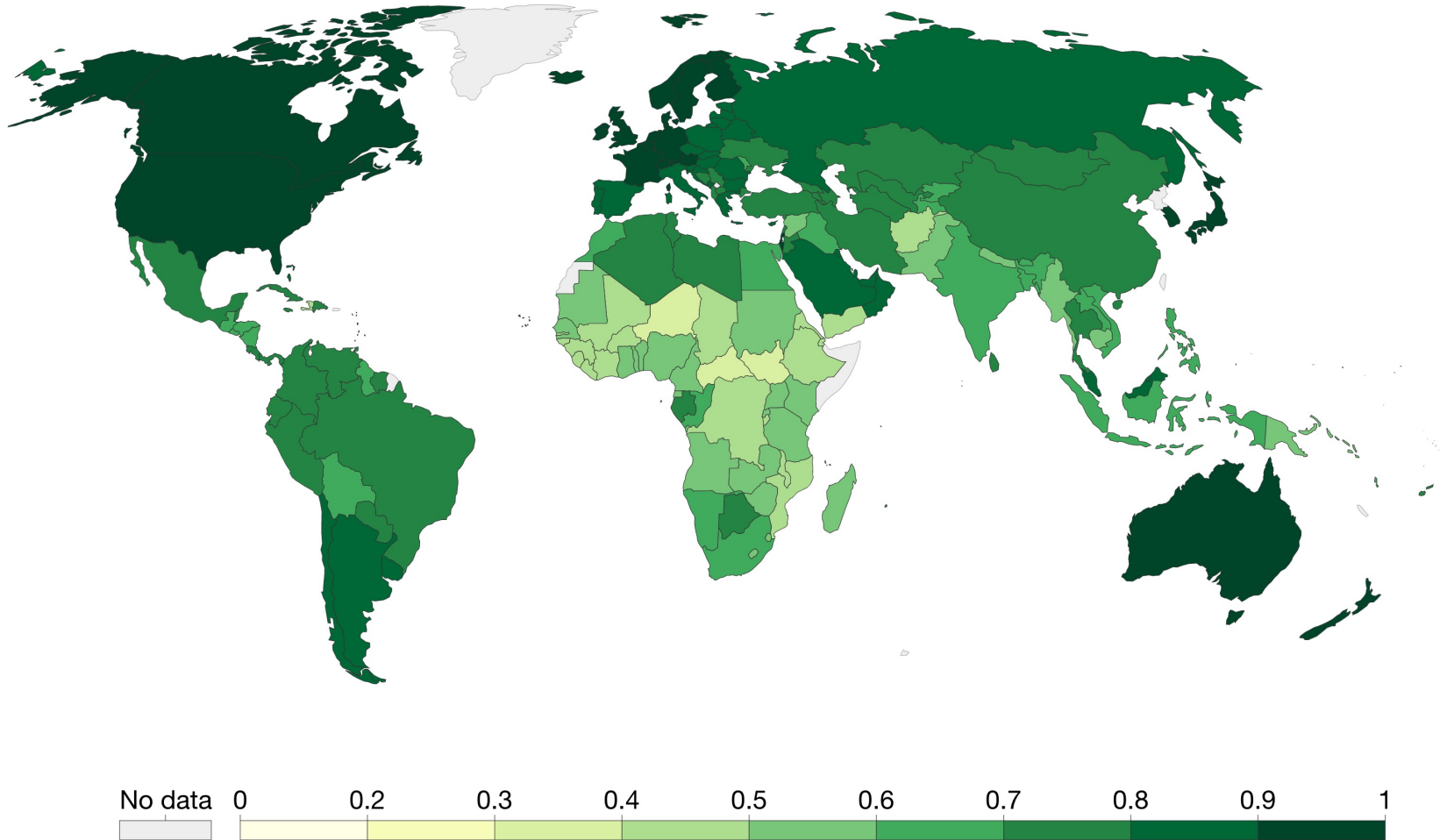
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- **Let's say you look at the HDI and notice Cuba does relatively well**
- **You might correctly conclude that its level of development is relatively high**
- **BUT, the index erases the useful knowledge that Cuba has an amazing health care system and low income levels**
- **So why not just look at the separate measures?**

Human Development Index, 2017

The Human Development Index (HDI) is a summary measure of key dimensions of human development: a long and healthy life, a good education, and having a decent standard of living.

Our World
in Data



Source: UNDP (2018)

OurWorldInData.org/human-development-index/ • CC BY

Classic inequality measure: Gini coefficient

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- **Distribution of people within a population with their wealth:**

PERSON	WEALTH
Richest	4,000,000
2 nd Richest	3,200,000
3 rd Richest	1,800,000
4 th Richest	1,270,000
5 th Richest	1,150,000
6 th Richest	1,100,000
7 th Richest	950,000
8 th Richest	400,000
9 th Richest	33,000
10 th Richest (Poorest)	30,000
TOTAL:	13,933,000

Classic inequality measure: Gini coefficient

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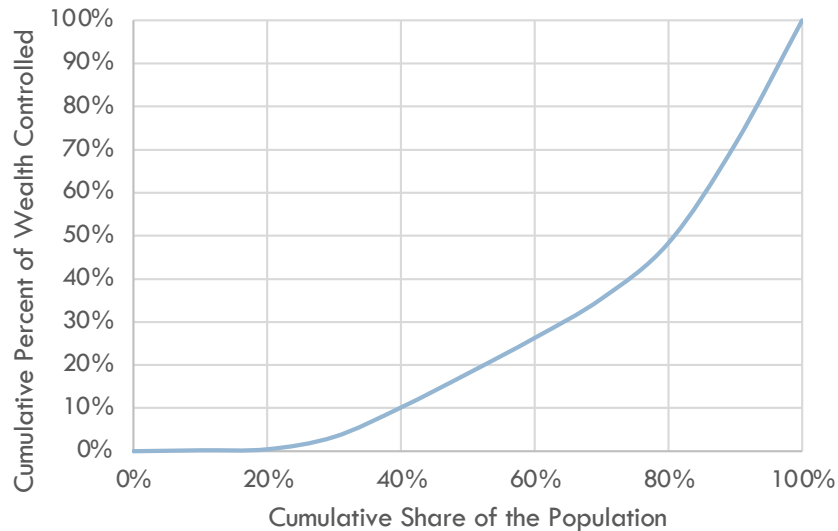
□ Distribution of people within a population with their wealth:

PERSON	WEALTH	CUMMULATIVE WEALTH	CUMULATIVE WEALTH AS A PERCENT OF TOTAL WEALTH	CUMULATIVE PERCENT OF THE POPULATION
Richest	4,000,000	13,933,000	100.00%	100%
2 nd Richest	3,200,000	9,933,000	71.29%	90%
3 rd Richest	1,800,000	6,733,000	48.32%	80%
4 th Richest	1,270,000	4,933,000	35.41%	70%
5 th Richest	1,150,000	3,663,000	26.29%	60%
6 th Richest	1,100,000	2,513,000	18.04%	50%
7 th Richest	950,000	1,413,000	10.14%	40%
8 th Richest	400,000	463,000	3.32%	30%
9 th Richest	33,000	63,000	0.45%	20%
10 th Richest (Poorest)	30,000	30,000	0.22%	10%

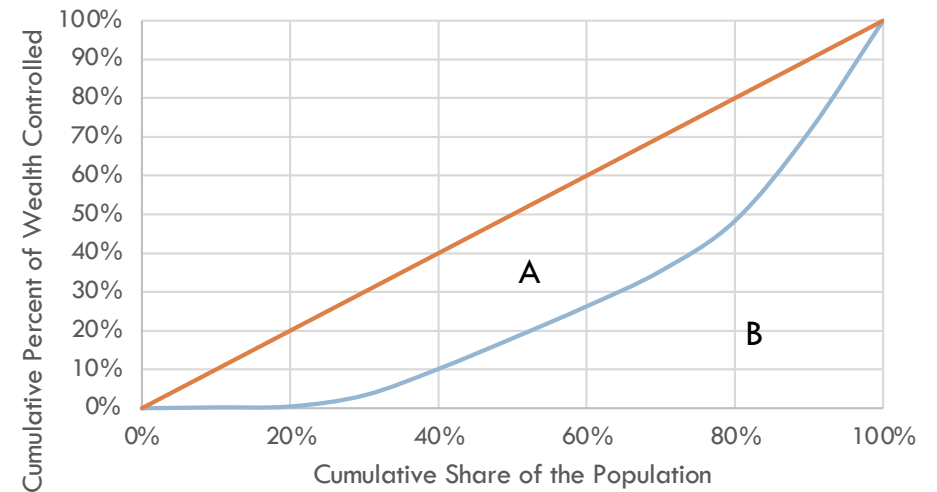
Lorenz Curve and the Gini Coefficient

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Lorenz Curve



Lorenz Curve (orange) Compared to Line of Perfect Equality (gray)



$$Gini\ Coefficient = \frac{A}{A + B}$$

Gini Coefficient (Without Calculus)

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- $(A + B) = \left(\frac{1}{2}\right) \times (1 \times 1) = \frac{1}{2}$
 - This is just the area of the triangle
- A is harder...
 - Without calculus, use Riemann Sums and triangles for approximation:

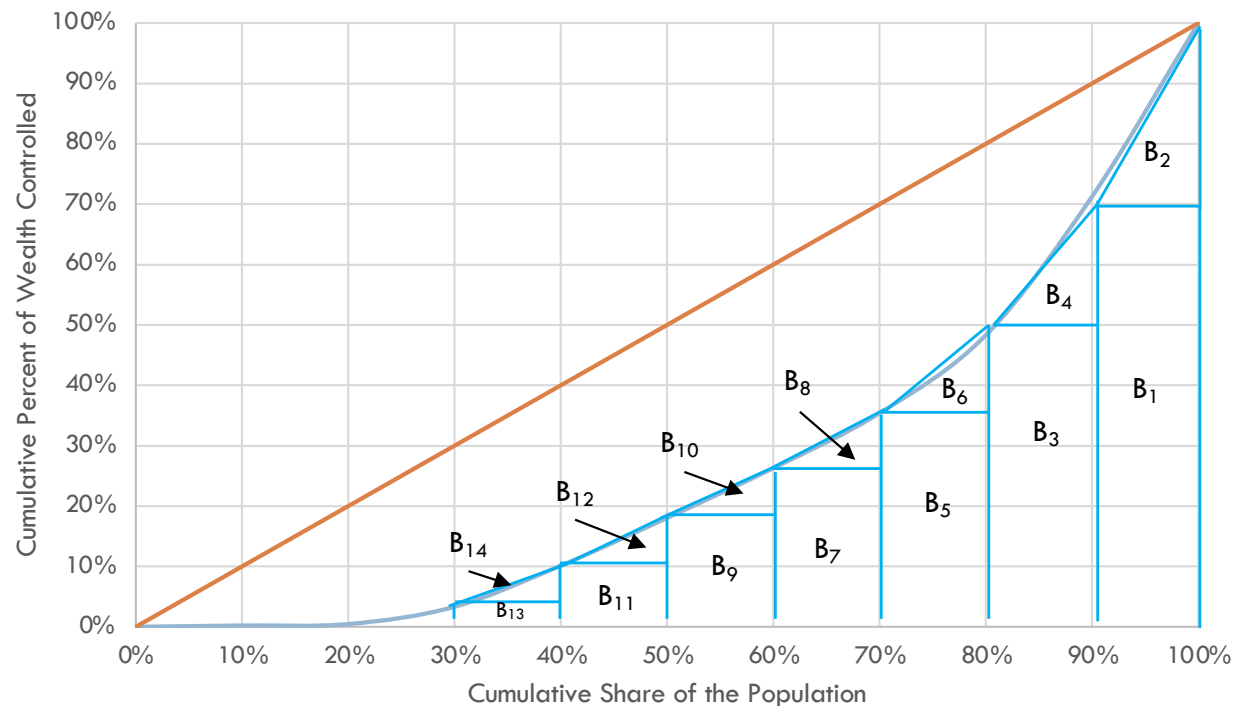
$$B = B_1 + B_2 + B_3 + \dots$$

- Then use your calculation above of $A + B$, to find A ,

$$A = (A + B) - B$$

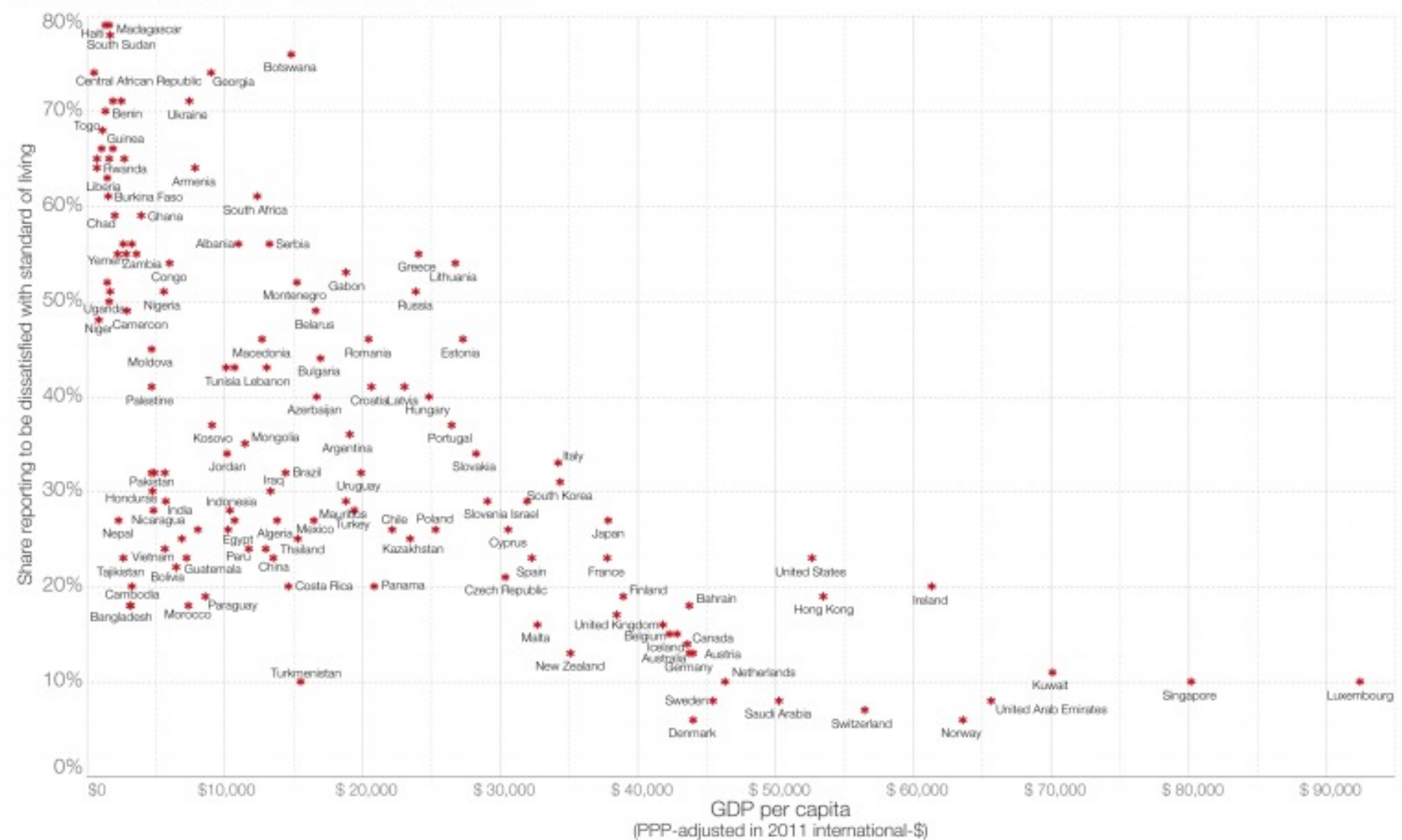
$$A = \frac{1}{2} - B$$

Lorenz Curve (orange) Compared to Line of Perfect Equality (gray)



Dissatisfaction with standard of living vs GDP per capita

Shown on the y-axis is the share that answered 'dissatisfied' to the question "Are you satisfied or dissatisfied with your standard of living, all the things you can buy and do?".



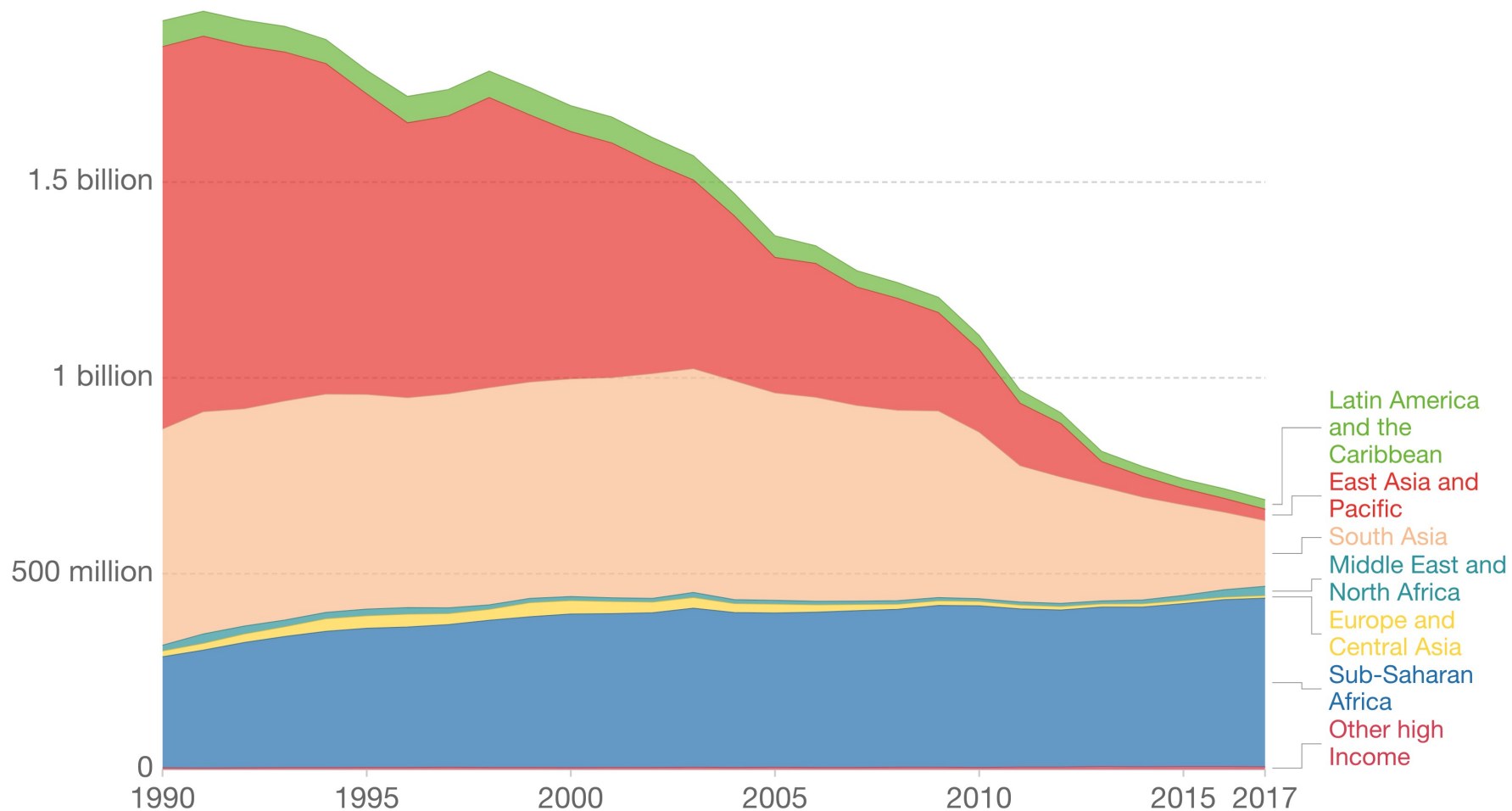
Data source: GDP per capita data from the World Bank; survey data on the satisfaction with living standards from the Gallup World Poll. The visualization is available at [OurWorldinData.org](https://ourworldindata.org) where you find more visualizations and research on global development.

Licensed under CC-BY-SA by the author Max Roser.

Total population living in extreme poverty by world region

Our World
in Data

Extreme poverty is defined as living with per capita household consumption below 1.90 international dollars per day (in 2011 PPP prices). International dollars are adjusted for inflation and for price differences across countries.



Source: PovcalNet (World Bank)

OurWorldInData.org/extreme-poverty/ • CC BY

Note: Consumption per capita is the preferred welfare indicator for the World Bank's analysis of global poverty. However, for a number of countries poverty is measured in terms of income. An income basis is common amongst high income countries and Latin American countries.

Data Sources

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- **Raw data on individuals are collected by national statistical agencies for individual countries**
- **Macroeconomic data are collected and stored by the World Bank**
- **You can get your hands on raw macroeconomic data from the World Bank's World Development Indicators (WDI) Database**
 - ▣ Just follow this link:
<https://databank.worldbank.org/source/world-development-indicators>
- **These data come in Excel files you can use yourselves**
 - ▣ Consider using them in your memos if relevant

GINI Coefficient (with calculus)

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First use Excel to find the approximate function for the Lorenz curve:

- 1. Plot out the Lorenz Curve in Excel**
- 2. Right click on any of the data points on the Lorenz Curve in the chart**
 1. Select “Add Trendline...”
 2. Choose “Polynomial” and select Order = 6 (This is allowing for a super flexible model to approximate the curve)
 3. Select “Display Equation on Chart”
- 3. The estimated equation for the line should now be on the chart you made**
 1. For the data in this presentation, this should be,
$$F(x) = -23.057x^6 + 72.15x^5 - 82.49x^4 + 42.382x^3 - 8.5531x^2 + 0.5684x - 0.0007$$
- 4. Integrate the area underneath the Lorenz Curve between 0 and 1 (even though the chart displays in percentages, the range is 0 to 1) to find B:**

GINI Coefficient (with calculus)

Continued

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$$\int_0^1 (-23.057x^6 + 72.15x^5 - 82.49x^4 + 42.382x^3 - 8.5531x^2 + 0.5684x - 0.0007)dx = 0.2611 = B$$

- **Avoid doing this by hand by going to <https://www.wolframalpha.com> and entering in “integral of $y = -23.057x^6 + 72.15x^5 - 82.49x^4 + 42.382x^3 - 8.5531x^2 + 0.5684x - 0.0007$ between 0 and 1” into the field at the top of the page.**

$$(A + B) - B = 0.5 - 0.2611 = 0.2389 = A$$

$$Gini\ Coefficient = \frac{A}{A + B} = \frac{0.2389}{0.5} = 0.4778$$