



Redefining Poverty.

Looking at poverty from a human perspective

Michael Ghattas - Chan Kim

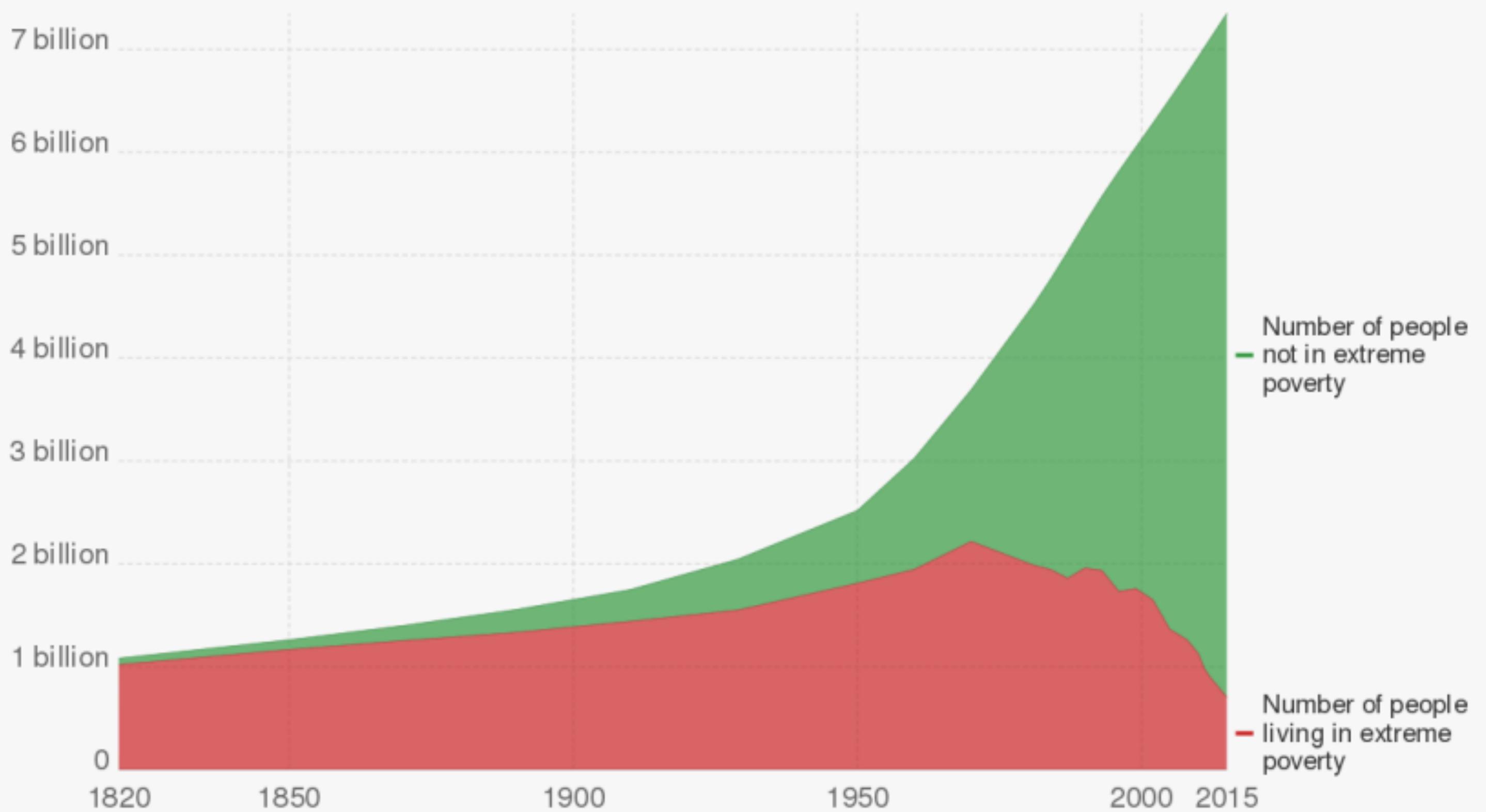
[STAT 3400] Fall-2021

What does it mean for the individual?

Is it money, purchasing power, etc...

World population living in extreme poverty, 1820-2015

Extreme poverty is defined as living at a consumption (or income) level below 1.90 "international \$" per day. International \$ are adjusted for price differences between countries and for price changes over time (inflation).



Source: World Poverty in absolute numbers - OWID based on World Bank (2016) and Bourguignon and Morrisson (2002)

Income Level at 50% of Median Income (Poverty-Level Income)

Luxembourg	\$21,637.55
Switzerland	\$20,553.36
Norway	\$19,525.30
Canada	\$16,942.49
Australia	\$16,708.22
Austria	\$16,305.45
United States	\$16,037.50
Denmark	\$16,034.55
Belgium	\$15,705.28
Sweden	\$15,423.69
Netherlands	\$15,344.69
Iceland	\$14,957.63
Ireland	\$14,742.24
Finland	\$14,129.62
Germany	\$14,049.92
New Zealand	\$13,996.03
France	\$13,497.82
United Kingdom	\$12,622.36
Italy	\$11,891.53
Japan	\$11,709.54
Slovenia	\$11,665.74
Korea	\$11,499.50
Spain	\$11,412.71
Israel	\$11,007.96
Czech Republic	\$9,276.43
Estonia	\$9,042.30
Portugal	\$8,442.41
Slovak Republic	\$8,329.14
Poland	\$8,095.59
Latvia	\$7,327.09
Greece	\$6,905.47
Hungary	\$6,574.25
Chile	\$5,295.00
Mexico	\$2,918.28

\$0.00 \$5,000.00 \$10,000.00 \$15,000.00 \$20,000.00 \$25,000.00

Project Background

The Why?

- Understand how poverty is economically calculated
- Identify how the average person relates to poverty
- Scale the individual perspective to an international level
- Re-examine how poverty is economically calculated based on the perspective of the common individual
- Randomly select a group of countries to gather observations
- Report on findings





THE WORLD BANK

Experiment & Data

The How?



WORLD TRADE
ORGANIZATION



INTERNATIONAL
MONETARY FUND



United Nations

- Economic data is widely available in many forms
- Finding the most reliable and up-to-date data is crucial
- Filtering through the different variations of economic formulas
- Selecting the single comprehensive source that is the subject matter expert
- Understanding their scope scale, and process
- Searching through and confirming the availability of the needed data
- Examining the data in preparation for the work

Experiment & Data

The How?

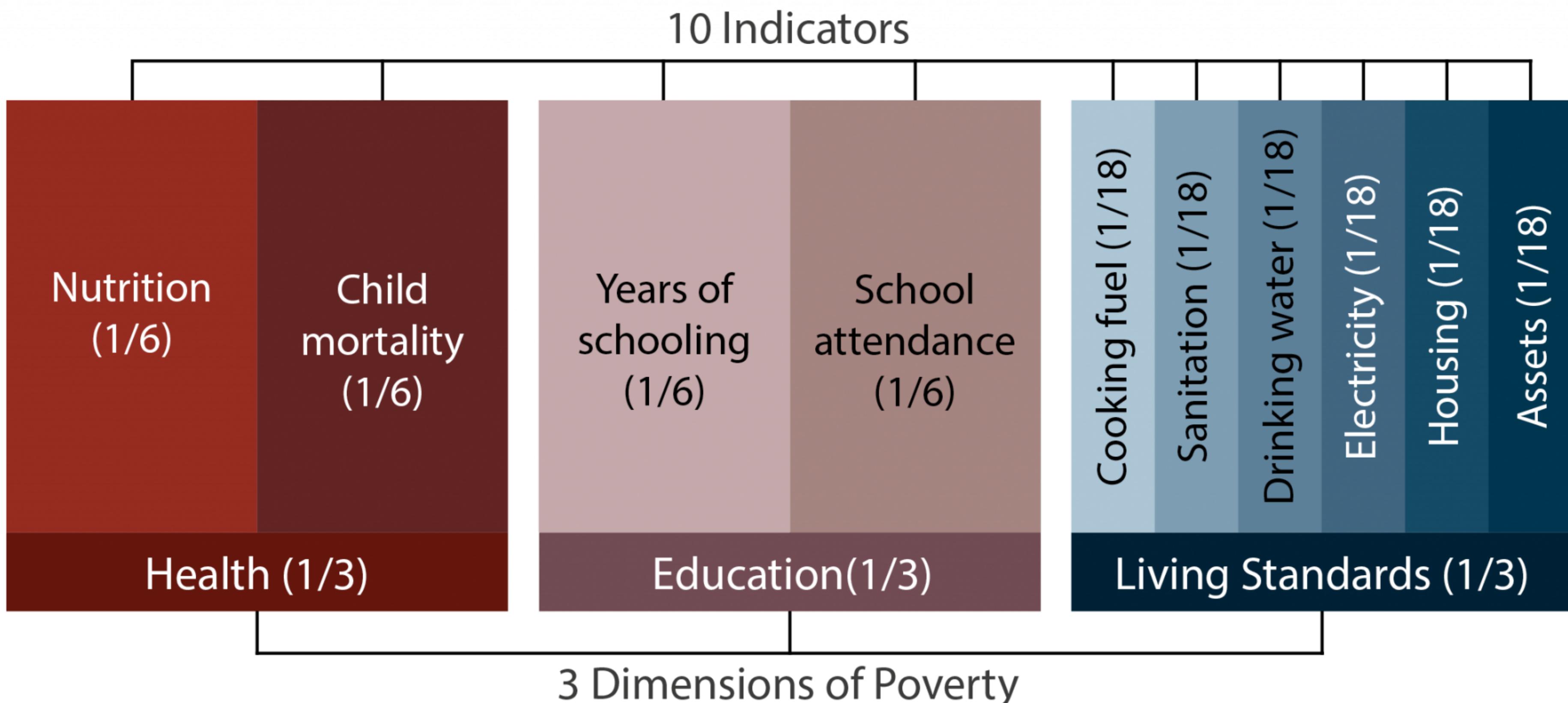
- Many gaps present in the data based on timeline
- Avoid years of extreme economic situations (i.e 2006-2008, 2020-2021, etc.)
- Let the available data dictate the countries random selection
- Scrub and clean the data
- Mitigate gaps in data by taking means and averages
- Create a uniform format for the .csv files based on countries and means
- Build the needed data frames

Table 1: Multidimensional Poverty Index: developing countries

		SDG 1.2												SDG 1.2		SDG 1.1										
		Multidimensional Poverty Index			Population in multidimensional poverty						Population vulnerable to multidimensional poverty			Contribution of deprivation in dimension to overall multidimensional poverty			Population living below income poverty line (%)									
		Year and survey	b	Index	Headcount	Intensity of deprivation	Number of poor (year of the survey)	Number of poor (2018)	Inequality among the poor	Population in severe multidimensional poverty	a	Health	Education	Standard of living	National poverty line	PPP \$1.90 a day	2008-2019	c	2008-2018	c						
Country	2008-2019	Value	(%)	(%)	(thousands)	(thousands)	Value	(%)	(%)	(%)		(%)	(%)	(%)	2008-2019	c	2008-2018	c								
Estimates based on surveys for 2014–2019																										
Afghanistan	2015/2016 D	0.272	d	55.9	d	48.6	d	19,783	d	20,783	d	0.020	d	24.9	d	18.1	d	10.0	d	45.0	d	45.0	d	54.5		
Albania	2017/2018 D	0.003		0.7		39.1		20		20		..	e	0.1		5.0		28.3		55.1		16.7		14.3	1.7	
Angola	2015/2016 D	0.282		51.1		55.3		14,740		15,745		0.024		32.5		15.5		21.2		32.1		46.8		36.6	47.6	
Armenia	2015/2016 D	0.001		0.2		36.2		5		6		..	e	0.0		2.7		33.1		36.8		30.1		23.5	2.1	
Bangladesh	2019 M	0.104		24.6		42.2		40,176		39,764		0.010		6.5		18.2		17.3		37.6		45.1		24.3	14.8	
Belize	2015/2016 M	0.017		4.3		39.8		16		16		0.007		0.6		8.4		39.5		20.9		39.6		
Benin	2017/2018 D	0.368		66.8		55.0		7,672		7,672		0.025		40.9		14.7		20.8		36.3		42.9		40.1	49.5	
Botswana	2015/2016 N	0.073	o	17.2	o	42.2	o	372	o	388	o	0.008	o	3.5	o	19.7	o	30.3	o	16.5	o	53.2	o	19.3	16.1	
Brazil	2015 N	h	0.016	d	3.8	d	42.5	d	7,856	d	8,048	d	0.008	d	0.9	d	6.2	d	49.8	d	22.9	d	27.3	d	..	4.4
Burundi	2016/2017 D	0.403		74.3		54.3		8,040		8,298		0.022		45.3		16.3		23.3		27.5		49.2		64.9	71.8	
Cambodia	2014 D	0.170		37.2		45.8		5,680		6,043		0.015		13.2		21.1		21.8		31.7		46.6		17.7	..	
Cameroon	2014 M	0.243		45.3		53.5		10,281		11,430		0.026		25.6		17.3		23.2		28.2		48.6		37.5	23.8	
Chad	2014/2015 D	0.533		85.7		62.3		12,089		13,260		0.026		66.1		9.9		20.1		34.4		45.5		46.7	38.4	
China	2014 N	i	0.016	j,l	3.9	j,l	41.4	j,l	54,369	j,l	55,464	j,l	0.005	j,l	0.3	j,l	17.4	j,l	35.2	j,l	25.6	j,l	1.7	0.5		
Colombia	2015/2016 D	0.020	d	4.8	d	40.6	d	2,335	d	2,407	d	0.009	d	0.8	d	6.2	d	12.0	d	39.5	d	48.5	d	27	4.1	
Congo	2014/2015 M	0.112		24.3		46.0		1,178		1,273		0.013		9.4		21.3		23.4		20.2		56.4		40.9	37	
Congo (Democratic Republic of the)	2017/2018 M	0.331		64.5		51.3		54,239		54,239		0.020		36.8		17.4		23.1		19.9		57.0		63.9	76.6	
Côte d'Ivoire	2016 M	0.236		46.1		51.2		10,975		11,549		0.019		24.5		17.6		19.6		40.4		40.0		46.3	28.2	
Cuba	2017 N	0.002	d	0.4	d	36.8	d	50	d	50	d	0.003	d	0.0	d	1.6	d	25.8	d	32.2	d	42.0	d	
Dominican Republic	2014 M	0.015	d	3.9	d	38.9	d	394	d	412	d	0.006	d	0.5	d	5.2	d	29.1	d	35.8	d	35.0	d	22.8	0.4	
Ecuador	2013/2014 N	0.018	g	4.6	g	39.9	g	730	g	782	g	0.007	g	0.8	g	7.6	g	40.4	g	23.6	g	35.9	g	25	3.3	
Egypt	2014 D	0.019	l	5.2	l	37.6	l	4,670	l	5,083	l	0.004	l	0.6	l	6.1	l	39.8	l	53.2	l	7.0	l	32.5	3.2	
El Salvador	2014 M	0.032		7.9		41.3		495		505		0.009		1.7		9.9		15.5		43.4		41.1		29.2	1.5	
Eswatini (Kingdom of)	2014 M	0.081		19.2		42.3		210		218		0.009		4.4		20.9		29.3		17.9		52.8		58.9	28.4	
Ethiopia	2016 D	0.489		83.5		58.5		86,513		91,207		0.024		61.5		8.9		19.7		29.4		50.8		23.5	30.8	
Gambia	2018 M	0.204		41.6		49.0		948		948		0.018		18.8		22.9		29.5		34.6		35.9		48.6	10.1	
Georgia	2018 M	0.001	g	0.3	g	36.6	g	14	g	14	g	..	e	0.0	g	2.1	g	47.1	g	23.8	g	29.1	g	20.1	4.5	
Ghana	2014 D	0.138		30.1		45.8		8,188		8,952		0.016		10.4		22.0		22.3		30.4		47.2		23.4	13.3	
Guatemala	2014/2015 D	0.134		28.9		46.2		4,694		4,981		0.013		11.2		21.1		26.3		35.0		59.3		8.7		
Guinea	2018 D	0.373		66.2		56.4		8,220		8,220		0.025		43.5		16.4		21.4		38.4		40.3		55.2	35.3	
Guinea-Bissau	2014 M	0.372		67.3		55.3		1,139		1,261		0.025		40.4		19.2		21.3		33.9		44.7		69.3	67.1	
Guyana	2014 M	0.014		3.4		41.8		26		26		0.008		0.7		5.8		31.5		18.7		49.8		
Haiti	2016/2017 D	0.200		41.3		48.4		4,532		4,590		0.019		18.5		21.8		24.6		57.0		58.5		24.2		
India	2015/2016 D	0.123		27.9		43.9		369,643		377,492		0.014		8.8		19.3		31.9								

The Response & Predictors

Multidimensional Poverty Index (MPI)



The global Multidimensional Poverty Index (MPI) is an international measure of acute multidimensional poverty.

It complements traditional monetary poverty measures by capturing the acute deprivations in health, education, and living standards that a person faces simultaneously.

GDP per Capita

is a measure of a country's economic output
that accounts for its number of people

It divides the country's gross domestic
product by its total population

$$\text{Per capita real GDP} = \frac{\text{Real GDP}}{\text{Population}}$$

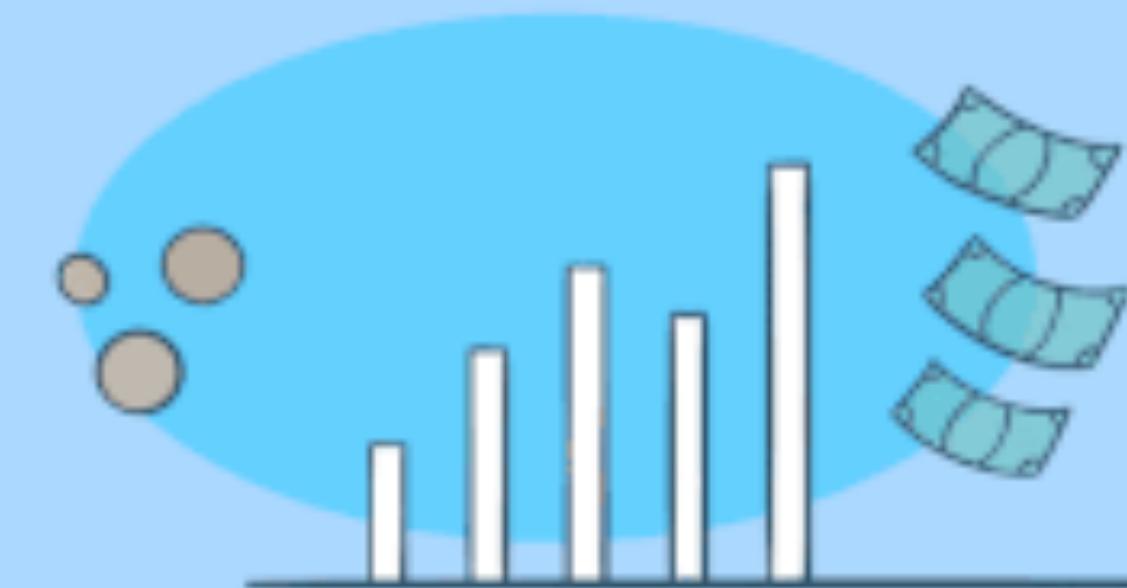


The Components of GDP



Personal Consumption Expenditures

- Goods can be durable (cars, furniture, large appliances) or non-durable (clothing, food, fuel)
- Services include banking, health care, and education

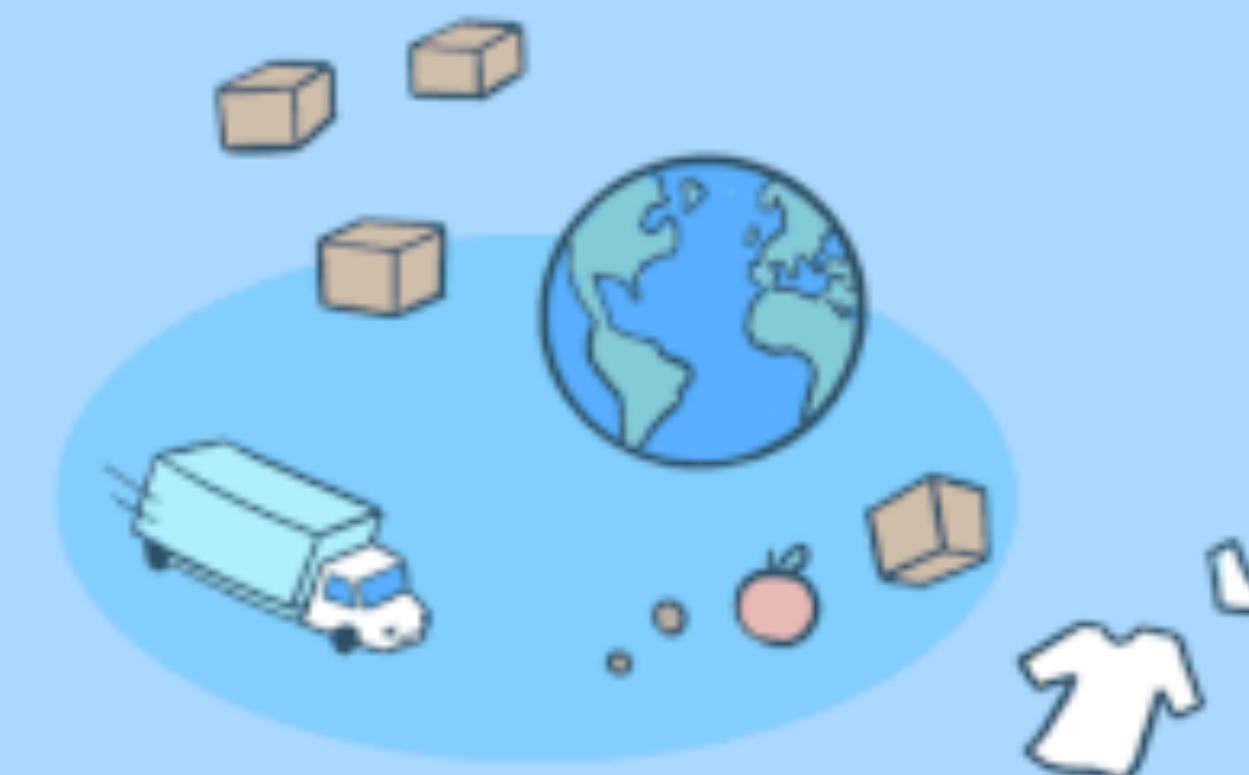


Business Investment

- Divided into two sub-components: fixed investment and change in private inventory



Government Spending



Net Exports of Goods and Services

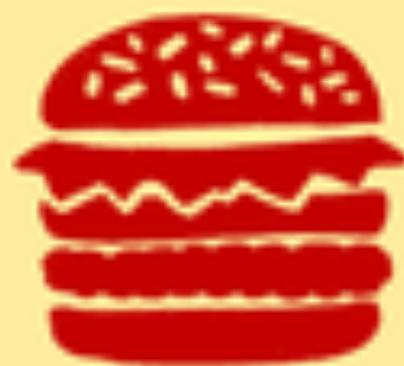
Purchasing power parity = $\frac{\text{Cost of good X in currency 1}}{\text{Cost of good X in currency 2}}$





What Is Purchasing Power Parity?

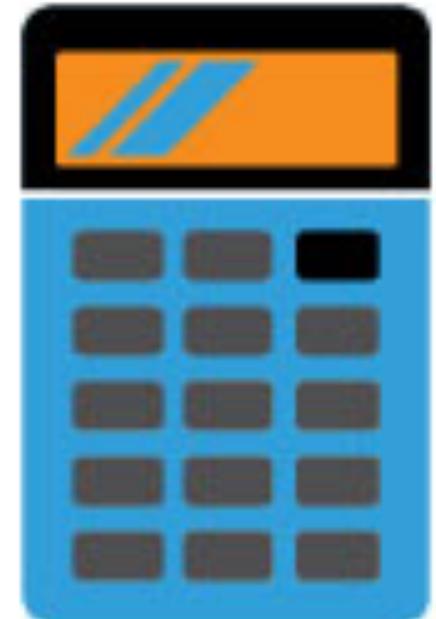
A theoretical exchange rate
that allows you to buy the
same amount of goods and
services in every country



Example: If you want
to live cheap, and
you can move to any
country in the world,
compare prices of a
Big Mac



Government agencies
use it to compare the
output of countries
that use different
exchange rates



**Consumer
Price Index =** $\frac{\text{Value of Market Basket in the Given Year}}{\text{Value of Market Basket in the Base Year}} \times 100$



Why Is Consumer Price Index Important?



It measures inflation

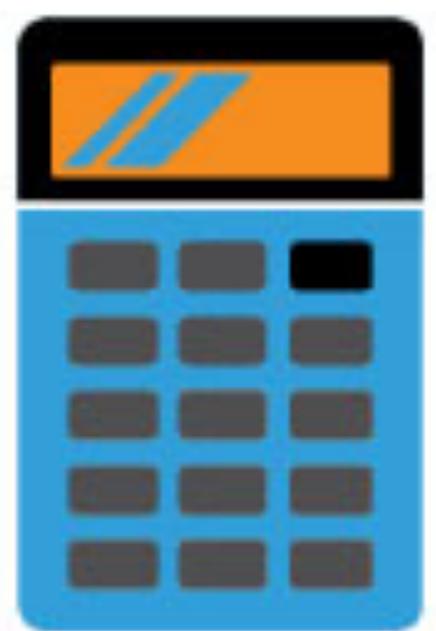
GDP



It's used to adjust
other government
economic indicators



It's used to improve
benefit levels



$$\text{Unemployment Rate Formula} = \frac{\text{No. of Unemployed Persons}}{\text{No. of Employed Persons} + \text{No. of Unemployed Persons}}$$



How to Calculate the Unemployment Rate



Workers Who Count as “Unemployed”

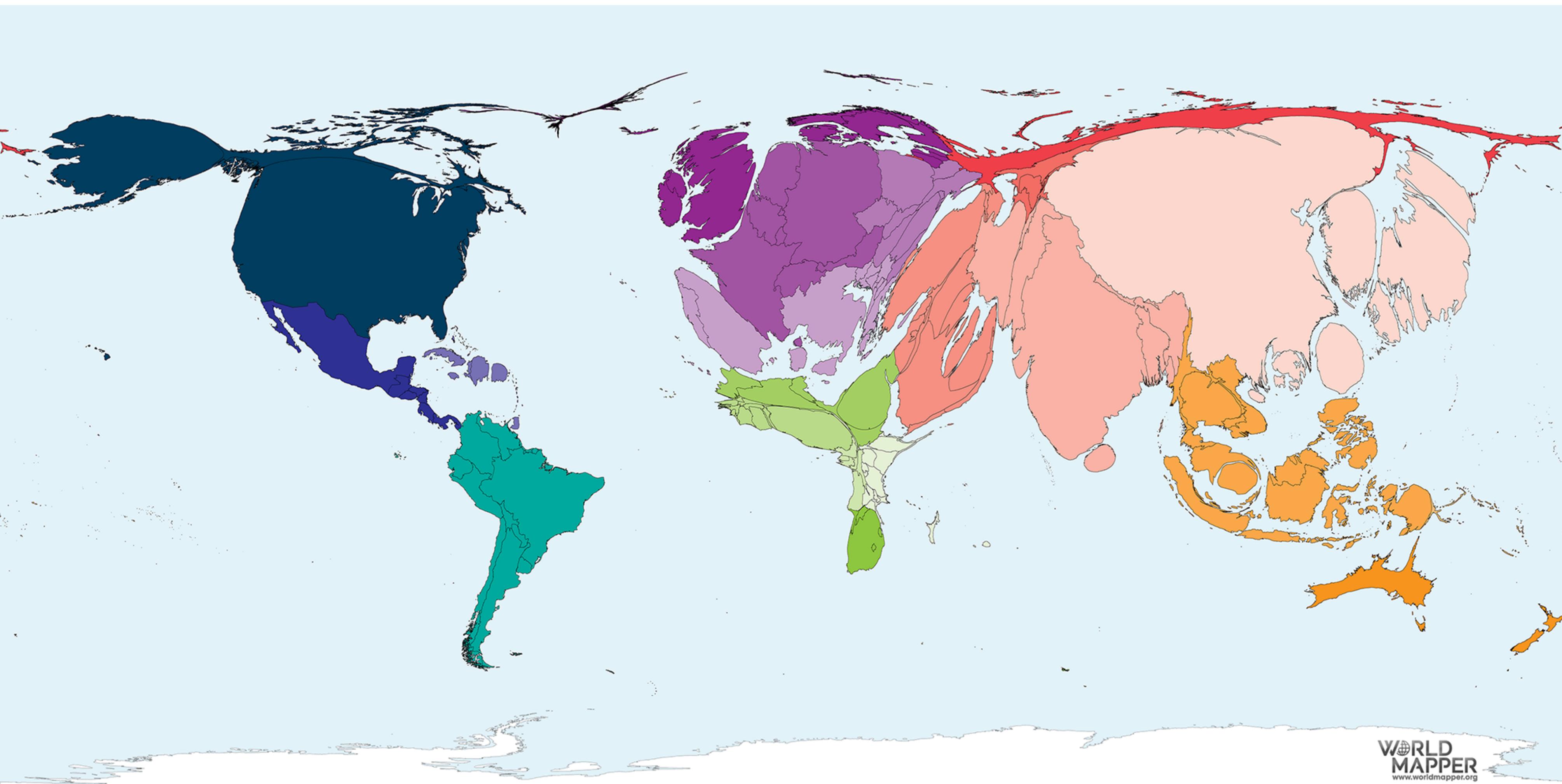
- 16 years or older
- Available to work full-time in the past 4 weeks
- Actively looking for work in the past 4 weeks
- Exception: temporarily laid off workers



Tested Samples

The Who?

We analyzed the data of the following 17 randomly selected countries:



Bangladesh
Democratic Republic of Congo
Dominican Republic
Jordan
Lesotho
Malawi
Mongolia
Morocco
Nigeria
Peru
Philippines
Senegal
Sierra Leone
South Africa
Suriname
Togo
Zimbabwe

Data Analysis

Our Findings

- Our model was a good fit for 12 countries out of 17 tested ($\text{adj.R}^2 \geq 0.65$)
 - More research needed for the fit disparities
- The predictors of our model had an effect on the model for 4 countries ($P\text{-Value} \leq 0.05$)
 - UEM, CPI, PPP, then GDP (In that order.)
 - UEM was the most significant
- The predictors of all 4 countries had high variance
 - UEM, CPI, PPP, then GDP (In that order)
 - UEM had the highest variance
- All 4 countries are from Africa (Lesotho, Nigeria, Togo, and Zimbabwe)
 - More research needed to identify why
 - Political factors can be of interest



```

Zimbabwe <- data.frame(UEM$Zimbabwe, MPI$Zimbabwe, CPI$Zimbabwe, GDP$Zimbabwe, PPP$Zimbabwe)
Lmod_Zimbabwe = lm(MPI.Zimbabwe ~ ., data = Zimbabwe)
summary(Lmod_Zimbabwe)

anova_Zimbabwe = aov(Lmod_Zimbabwe)
summary(anova_Zimbabwe)

Call:
lm(formula = MPI.Zimbabwe ~ ., data = Zimbabwe)

Residuals:
    1     2     3     4     5     6 
-0.000143  0.001711  0.004362 -0.005897  0.001147 -0.001181 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept) -9.029e-16 3.148e-03   0.00  1.0000    
UEM.Zimbabwe -5.597e-01 4.144e-03 -135.06  0.00471 **  
CPI.Zimbabwe  1.132e+00 9.255e-03  122.29  0.00521 **  
GDP.Zimbabwe   6.290e-02 5.926e-03   10.61  0.05981 .    
PPP.Zimbabwe -1.365e+00 8.088e-03 -168.81  0.00377 **  
---                                                            
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.007711 on 1 degrees of freedom
Multiple R-squared:  1, Adjusted R-squared:  0.9999 
F-statistic: 2.102e+04 on 4 and 1 DF,  p-value: 0.005173 

Df Sum Sq Mean Sq F value Pr(>F)    
UEM.Zimbabwe  1  1.7879  1.7879 30070.0  0.00367 **  
CPI.Zimbabwe  1  0.0093  0.0093  156.1  0.05085 .    
GDP.Zimbabwe  1  1.5085  1.5085 25371.8  0.00400 **  
PPP.Zimbabwe  1  1.6942  1.6942 28495.1  0.00377 **  
Residuals     1  0.0001  0.0001                  

---                                                            
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Nigeria <- data.frame(UEM$Nigeria, MPI$Nigeria, CPI$Nigeria, GDP$Nigeria, PPP$Nigeria)
Lmod_Nigeria = lm(MPI.Nigeria ~ ., data = Nigeria)
summary(Lmod_Nigeria)

anova_Nigeria = aov(Lmod_Nigeria)
summary(anova_Nigeria)

Call:
lm(formula = MPI.Nigeria ~ ., data = Nigeria)

Residuals:
    1     2     3     4     5     6 
 0.02209 -0.00307 -0.01378 -0.01608 -0.03036  0.04120 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept) 2.320e-15 2.437e-02   0.00  1.0000    
UEM.Nigeria -5.724e+00 3.860e-01 -14.83  0.0429 *  
CPI.Nigeria  5.351e-01 7.881e-02   6.79  0.0931 .    
GDP.Nigeria -2.119e+00 9.562e-02 -22.16  0.0287 *  
PPP.Nigeria  3.505e+00 3.195e-01   10.97  0.0579 .    
---                                                            
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.0597 on 1 degrees of freedom
Multiple R-squared:  0.9993, Adjusted R-squared:  0.9964 
F-statistic: 350.4 on 4 and 1 DF,  p-value: 0.04004 

Df Sum Sq Mean Sq F value Pr(>F)    
UEM.Nigeria  1  1.0838  1.0838 304.1  0.0365 *  
CPI.Nigeria  1  2.0844  2.0844  584.8  0.0263 *  
GDP.Nigeria  1  1.3992  1.3992  392.5  0.0321 *  
PPP.Nigeria  1  0.4290  0.4290  120.4  0.0579 .  
Residuals    1  0.0036  0.0036                  

---                                                            
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

Lesotho <- data.frame(UEM$Lesotho, MPI$Lesotho, CPI$Lesotho, GDP$Lesotho, PPP$Lesotho)
Lmod_Lesotho = lm(MPI.Lesotho ~ ., data = Lesotho)
summary(Lmod_Lesotho)

anova_Lesotho = aov(Lmod_Lesotho)
summary(anova_Lesotho)

Call:
lm(formula = MPI.Lesotho ~ ., data = Lesotho)

Residuals:
    1     2     3     4     5     6 
 0.004436  0.009241 -0.012939 -0.015937  0.027764 -0.012564 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept) 9.054e-16 1.557e-02   0.000  1.0000    
UEM.Lesotho 3.948e-01 3.340e-02  11.820  0.0537 .  
CPI.Lesotho 5.411e-03 1.996e-02   0.271  0.8315 .  
GDP.Lesotho -4.432e-01 2.393e-02 -18.523  0.0343 *  
PPP.Lesotho -5.898e-01 3.194e-02 -18.464  0.0344 *  
---                                                            
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.03815 on 1 degrees of freedom
Multiple R-squared:  0.9997, Adjusted R-squared:  0.9985 
F-statistic: 858.7 on 4 and 1 DF,  p-value: 0.02559 

Df Sum Sq Mean Sq F value Pr(>F)    
UEM.Lesotho  1  2.1816  2.1816 1499.188  0.0164 *  
CPI.Lesotho  1  0.0027  0.0027   1.853  0.4033 .  
GDP.Lesotho  1  2.3182  2.3182 1593.054  0.0159 *  
PPP.Lesotho  1  0.4961  0.4961  340.904  0.0344 *  
Residuals    1  0.0015  0.0015                  

---                                                            
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Senegal <- data.frame(UEM$Senegal, MPI$Senegal, CPI$Senegal, GDP$Senegal, PPP$Senegal)
Lmod_Senegal = lm(MPI.Senegal ~ ., data = Senegal)
summary(Lmod_Senegal)

anova_Senegal = aov(Lmod_Senegal)
summary(anova_Senegal)

Call:
lm(formula = MPI.Senegal ~ ., data = Senegal)

Residuals:
    1     2     3     4     5     6 
-0.5153  1.0161 -0.4208 -0.2364  0.4997 -0.3434 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept) -3.359e-16 5.625e-01   0.000  1.0000    
UEM.Senegal  7.256e-01 9.085e-01   0.799  0.571    
CPI.Senegal -1.559e-01 8.930e-01  -0.175  0.890    
GDP.Senegal -2.568e-01 8.727e-01  -0.294  0.818    
PPP.Senegal  9.362e-03 7.679e-01   0.012  0.992    
---                                                            
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.378 on 1 degrees of freedom
Multiple R-squared:  0.6203, Adjusted R-squared:  -0.8986 
F-statistic: 0.4084 on 4 and 1 DF,  p-value: 0.8073 

Df Sum Sq Mean Sq F value Pr(>F)    
UEM.Senegal  1  2.6169  2.6169   1.378  0.449    
CPI.Senegal  1  0.2585  0.2585   0.136  0.775    
GDP.Senegal  1  0.2257  0.2257   0.119  0.789    
PPP.Senegal  1  0.0003  0.0003   0.000  0.992    
Residuals    1  1.8986  1.8986                  

---                                                            
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

Takeaway and Further Considerations

- Complex Predictors are harder to work with
- Unemployment is the main cause of poverty, though no inverse relationship with GDP observed
- Some indication of a relationship between Inflation and purchasing power, though not enough to draw any conclusions
- We would like to test the model with more samples and over a longer timeline
- If more consistent results were achieved, prediction models would be a great next step



Thank You!

Success...



It's not always what you
see.