

# Extreme Poverty Storytelling

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## 1. Introduction

Eradicate extreme poverty and hunger was the first of eight Millennium Development Goals (MDGs) established by the United Nations. The MDGs were first proposed in 2000 during a meeting among many world leaders committed at improving social welfare and environmental sustainability across the globe - the Millennium Summit. At the meeting, one of the key targets defined for MDG1 (Eradicate Extreme Poverty) was to reduce extreme poverty rates by half until 2015. Since there was no clear metric to assert if a person is under extreme poverty condition, the following approach, first used by the World Bank, was adopted for our study: a person living on less than \$1.90 international dollars a day is considered to be extremely poor.

According to the most recent estimates (2015), there are around 730 million people (11% of the world population) living in extreme poverty. Consequently, there are people dying of hunger, malnourished children, limited access to education, water and sanitation, social discrimination and lots of other problems that in general context help create a social gap, leading to political and social instability.

Here, we focus on analyzing how the goal of eradicating extreme poverty has evolved during the last 30 years. In this research, we explored different indicators from the following sources: World Bank<sup>1</sup> and OECD<sup>2</sup>.

The remainder of this paper is organized as follows: In Section 2, we present the sources of the data collected to build our work. In Section 3, we describe some details of the implementation performed in this project. In Section 4, we present and discuss a set of visualization that helps understand how poverty is distributed around the world and how GDP and other indicators relate to it. Finally, in Section 5, we present our final considerations to the subject.

## 2. Data

The principal source of the data presented on this work was collected from the Organisation for Economic Co-operation and Development (OECD). The OECD is an inter-governmental organization that joins together 36 countries, founded in 1961 to promote economic development and facilitate negotiation among members of the group.

The data provided by the OECD is classified into topics, like agriculture, economic development, labor, etc. For each of these topics, the OECD keeps many indicators that allow for a thorough analysis. Some of them lack of substantial data, so we conducted our analysis on the ones that have greater representation in the dataset and are related to

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<sup>1</sup>[data.worldbank.org](http://data.worldbank.org)

<sup>2</sup>[data.oecd.org](http://data.oecd.org)

extreme poverty. Such indicators belong mostly to the following fields: education, health and economics.

Besides the OECD dataset, we also used data from The World Bank. The World Bank is an organization that covers a larger number of countries, 189. It is formed by a global partnership that aims at providing sustainable solutions on eradicating extreme poverty and bringing prosperity for the countries. The data gathered from this source also presents a historical series on indicators related to similar topics as the OECD: education, health, labor, agriculture, economics, etc. Although the topics are the same, they present distinct indicators and a careful analysis of both datasets was crucial for the development of our work.

### 3. Implementation

After pre-processing the data, we started plotting the visualizations. We used the `Plotly`<sup>3</sup> library to create interactive charts, `Python` programming language for the implementation of the project and `Jupyter Notebook`<sup>4</sup> environment. The project is available on the following repository: [github.com/torres07/pg-infoviz](https://github.com/torres07/pg-infoviz).

The `Plotly` library was chosen because we wanted the user to interact with the views. That way, some Interaction Principles [Shirley and Marschner 2009] were applied to allow users to explore data more fluidly, displaying details (e.g. tooltips) as the cursor navigates over the objects.

After completing the implementation, we created a presentation with the main visualizations on an HTML page. The presentation is also available on the repository cited previously. In the next section (Section 4), we introduce the chapters of our presentation briefing the main ideas of each one.

### 4. Visualization

We focused our work on analyzing how extreme poverty eradication has evolved along the years. In order to bring thorough insights on the problem, we divided our presentation into the following chapters:

#### 1. Extreme Poverty Around The World

Aims at familiarizing the readers with the problem. It shows how extreme poverty has shrunk over the years and how regions and countries have evolved on facing this issue.

#### 2. Gross domestic product (GDP) and extreme poverty

Compares the evolution of GDP per capita among the regions and how it reflects on the reduction of the percentage of the population living in extreme poverty. Furthermore, it analyzes what percentage of the GDP the different regions have been spending on health and education. For the most critical regions, we compare health and education indicators in the years 2000 and 2016, assessing if the expenditures have resulted in improvements in social welfare in these nations. At

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<sup>3</sup>[plot.ly](https://plot.ly)

<sup>4</sup>[jupyter.org](https://jupyter.org)

last, it compares the Official Development Assistance<sup>5</sup> (ODA) per capita received by each country, showing that the most critical regions are not the ones receiving most assistance.

### **3. South America countries and extreme poverty eradication**

Compares four countries: Brazil, Colombia, Argentina and, Chile, analyzing their expenditure on Education of the GDP and how it relates to extreme poverty rates. The same is done for an indicator that we believe to be strongly correlated with extreme poverty: infant mortality rate.

### **4. The future of extreme poverty**

Shows a projection for the population living in extreme poverty until 2030, which is the deadline proposed by the United Nations for ending extreme poverty worldwide. This projection considers two assumptions:

- (a) the average growth rates of consumption in all countries will be the same as the average growth rates from the past 10 years in each country;
- (b) the dispersion in the distribution of consumption in each country will remain unchanged.

In this section, we present all the distinct visualizations that compose the work. These visualizations were evaluated by a group of student from the Department of Informatics of PUC-Rio. Some of them were used more than once, in that case only one instance is presented in this paper. For each visualization, we explain why it was chosen, what advantages it brings to the reader comprehension and the student's insights on them.

Next, we present the question we proposed with the visualization that best answers the question. In a few cases, more than one visualization is presented, which means that they all could be used to convey the information we expect as an answer.

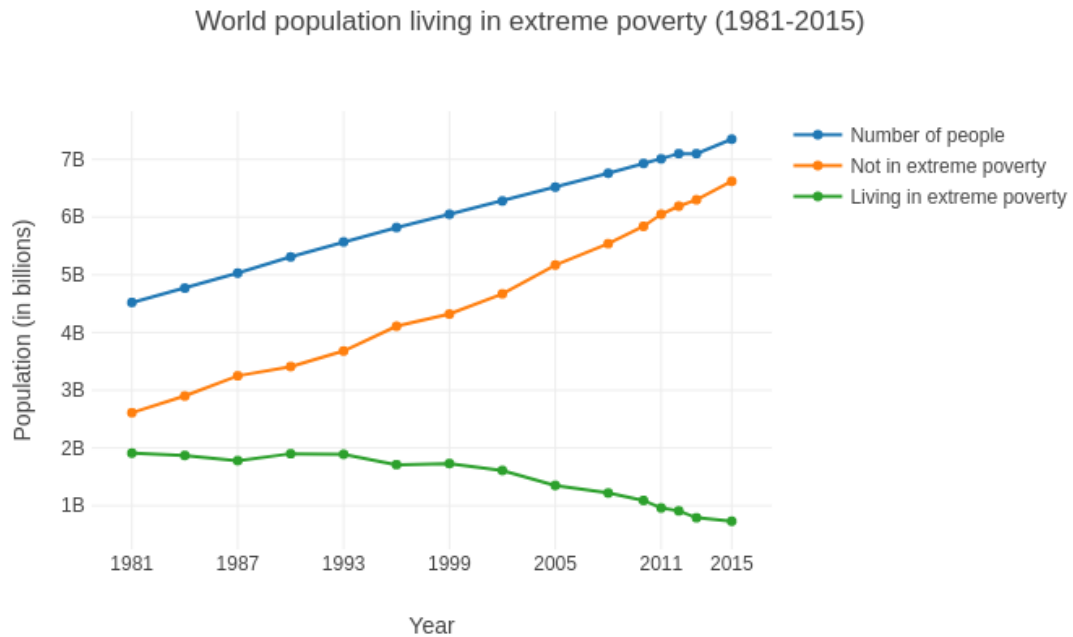
#### **4.1. How have we been evolving on eradicating extreme poverty?**

To answer this question, we created three different visual encodings: a line chart (Figure 1), a stacked area chart (Figure 2) and a stacked relative area chart (Figure 3). Each of them brings a different perspective on the evolution of extreme poverty shrinkage. In Figure 1, we trace three one-dimensional marks to convey the information, while in Figures 2 and 3, two-dimensional marks are used.

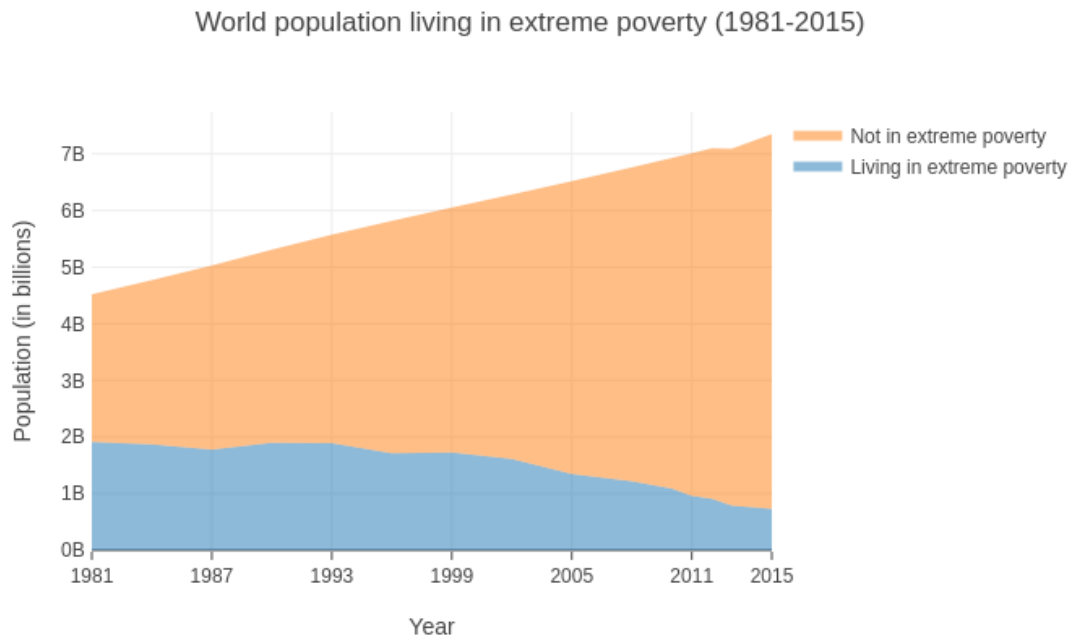
The group of students preferred Figure 1. Note that compared to figures 2 and 3, it is cleaner and easier to read, because it only uses one-dimensional marks. Based on the Visual Encodings Principles [Shirley and Marschner 2009], when the datatype is quantitative, humans tend to understand better slopes than areas as visual channels. In this case, the two-dimensional marks used in figure 2 bring no additional information to the subject, hence there is no advantage to using this chart in this particular case. On the other hand, figure 3 shows a percentual understanding of the evolution of extreme poverty shrinkage. Note that it uses the whole area available by the chart to convey the proportional information. Although figure 1 does not provide that information instantly, it gives us a sense of that percentage by observing how narrow the gap between the blue and orange lines have become along the years. Bear in mind that this gap is also represented by the green line on the chart.

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<sup>5</sup>[www.oecd-ilibrary.org/development/official-development-assistance-oda/indicator-group/english\\_5136f9ba-en](http://www.oecd-ilibrary.org/development/official-development-assistance-oda/indicator-group/english_5136f9ba-en)



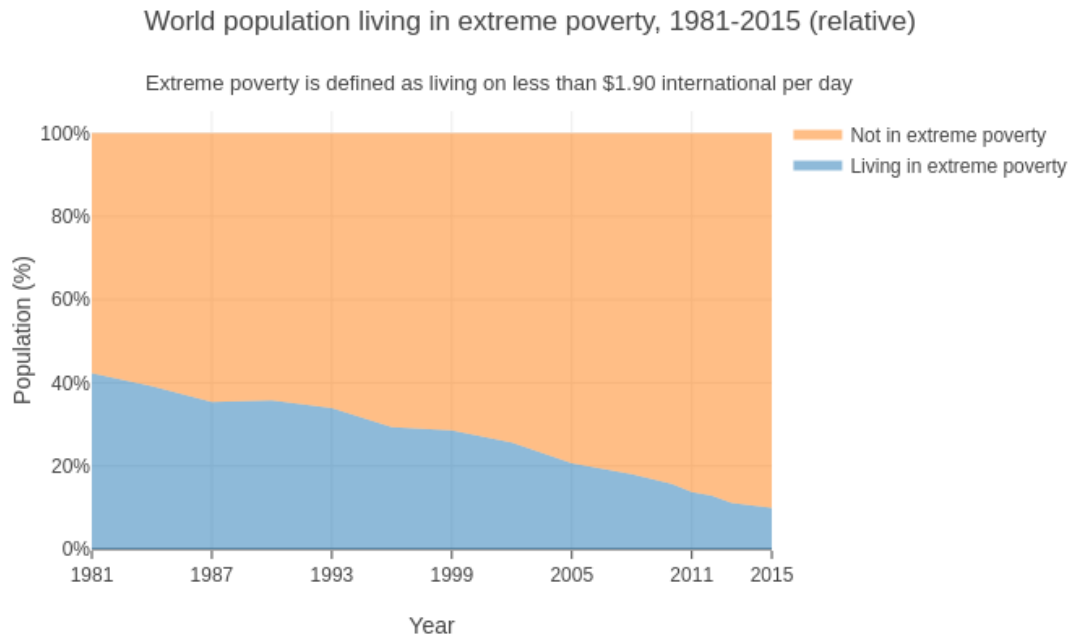
**Figure 1. Line chart of extreme poverty shrinkage.**



**Figure 2. Stacked area chart of extreme poverty shrinkage.**

#### 4.2. Which regions/countries are most critical and how have they evolved on facing the problem?

In order to identify how regions have evolved and which ones are still critical in extreme poverty, we used a line chart (Figure 4). The chart brings the percentage of the population

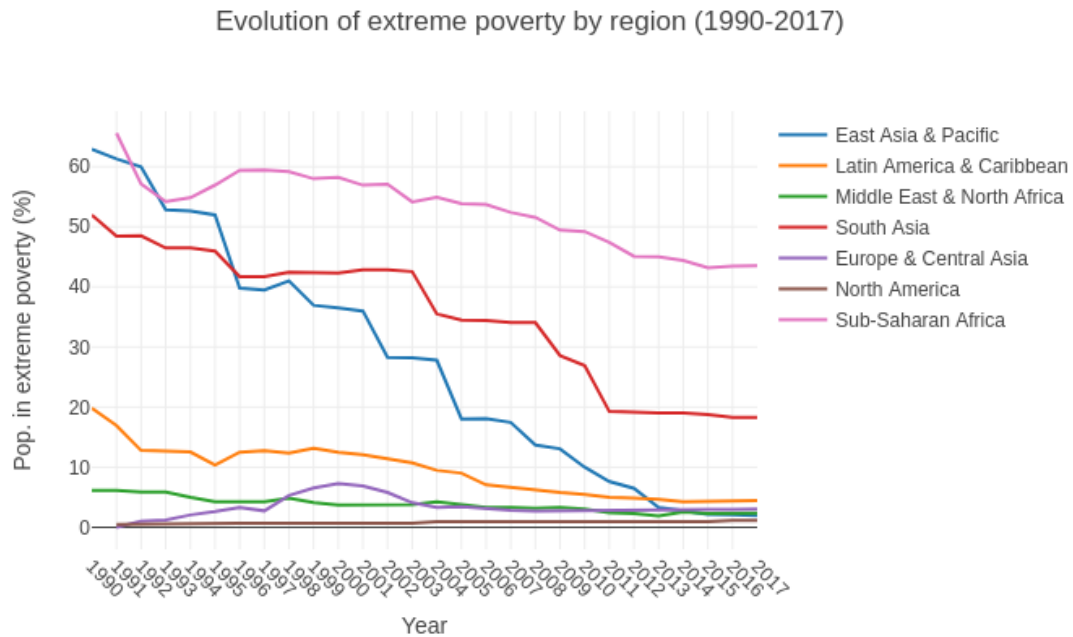


**Figure 3. Relative stacked area chart of extreme poverty shrinkage.**

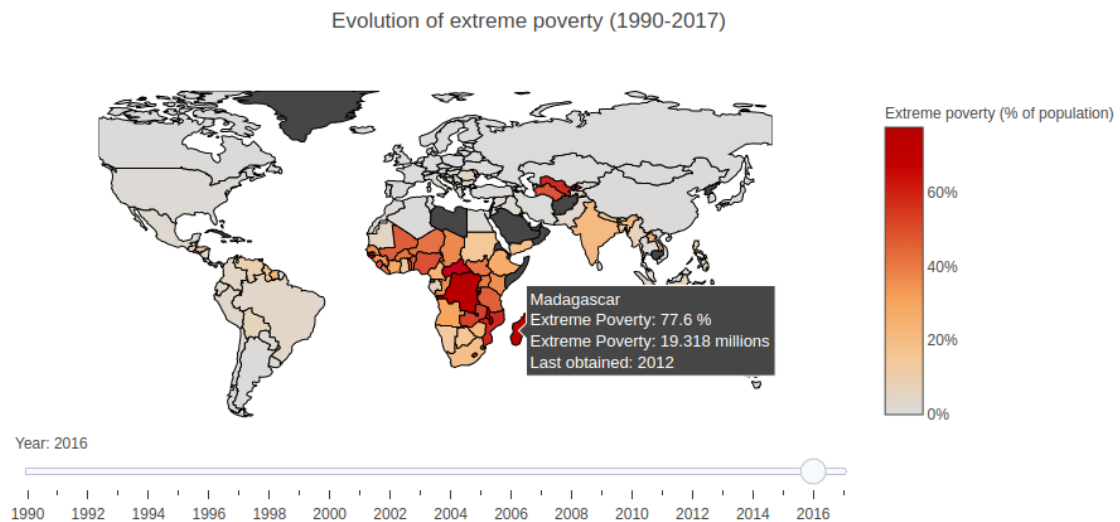
in extreme poverty along the years (1990-2017) by region. Through this chart, we can easily point out the critical regions nowadays and evaluate their evolution on facing the issue. For a deeper analysis, it becomes necessary to identify the specific countries that are struggling with extreme poverty. For that matter, we provide a choropleth map with a slider representing the years (Figure 5). The visual information is now conveyed through a color palette that has the intuit of classifying countries by their percentage of the population living in extreme poverty. That way, it is possible to represent a lot of information in an understandable and easily navigational manner.

#### **4.3. How has the GDP per capita evolved compared with extreme poverty?**

For this question, we proposed two small multiples charts, once they often produce a more effective visualization than trying to coerce all the data into a single plot [Heer et al. 2010]. Each separate chart represents a different region. Figure 6 and 7 shows only the regions: Sub-Saharan Africa and South Asia. Note that Figure 6 is a dual axis line chart of the percentage of the population in extreme poverty and GDP per capita along the years. For these examples, we can affirm that extreme poverty and GDP per capita tend to be negatively correlated. Based on that assumption, we plotted another chart (Figure 7), where we explore the correlation among these variables. Figure 7 shows a scatter graph between the percentage of the population in extreme poverty and GDP per capita. Both plots were presented for the group of students and they opted for Figure 6, under the argument that besides the correlation of the variables it is also possible to analyze timely tendencies, what is not achievable with only the scatter plot.



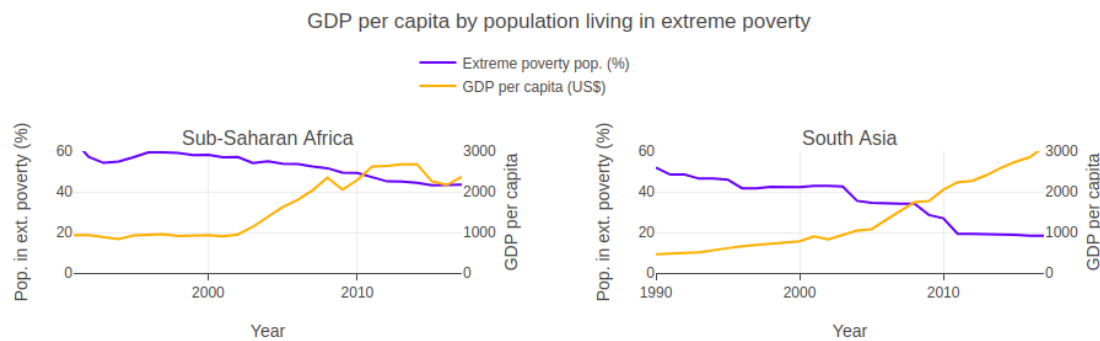
**Figure 4. Evolution of extreme poverty by region.**



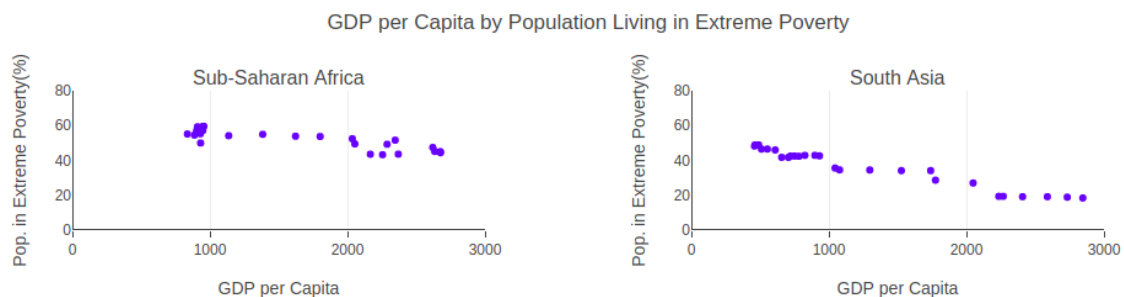
**Figure 5. Evolution of extreme poverty by country.**

#### 4.4. How large are the investments on health and education by region?

Our approach to answering this question is very similar to the one adopted for the previous question. We again use small multiples to separate the regions, as figures 8 and 9 show. Figure 8 reveals how the combined percentage of GDP invested in health and education has varied according to the GDP growth, through a stacked bar chart for individual investments (health and education) and a line chart for the GDP growth. Notice that together health and education percentual expenditures have varied slightly across the years



**Figure 6. Small multiples line chart comparing GDP per capita and percentage of population living in extreme poverty by region.**

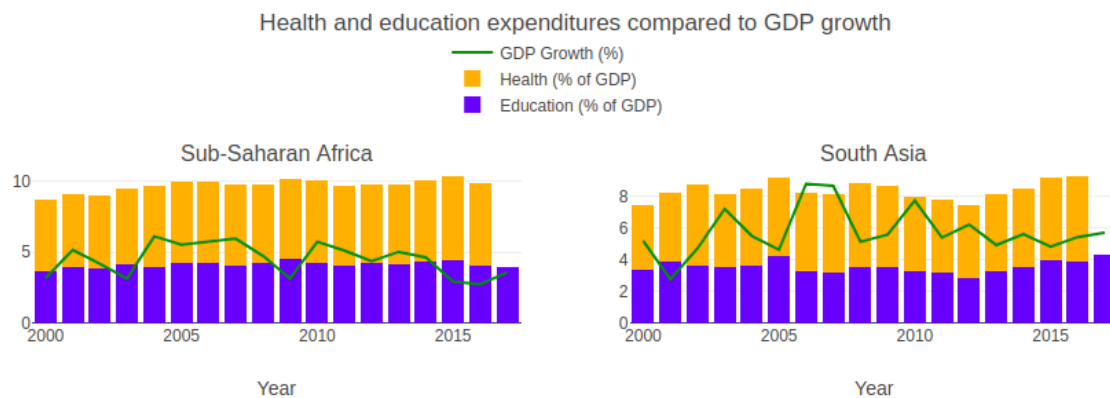


**Figure 7. Small multiples scatter plot of GDP per capita and percentage of population living in extreme poverty by region.**

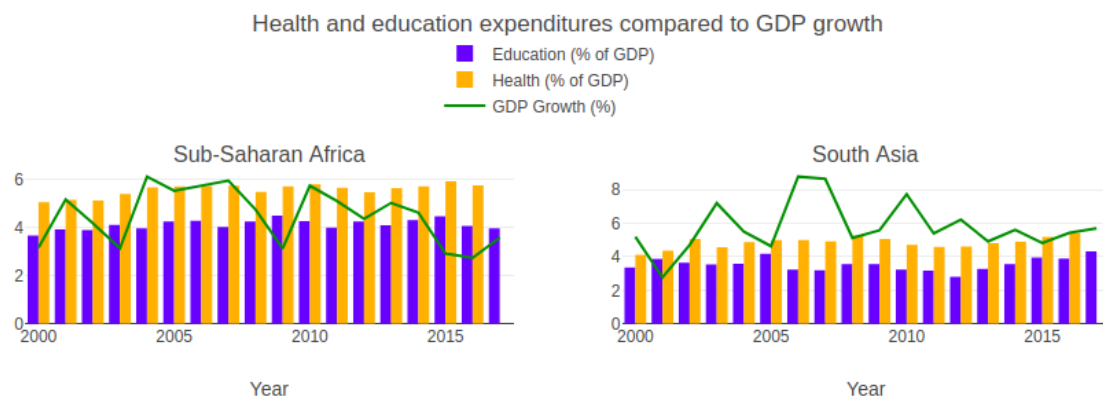
and seem to represent approximately 10% and 8% for Sub-Saharan Africa and South Asia respectively. The stacked bar chart, on the other hand makes it difficult to analyze the individual variations of education and health expenditures, we alternatively plotted a grouped bar chart (Figure 9) for understanding how the investment has varied individually across the years. When we asked the students for their analysis on which of these charts better answers the proposed question, they opted for Figure 8. According to them, it is not difficult to measure individual investment variation in Figure 8, because we only have two stacked variables in it and it also has the advantage of easily giving us the combined percentual variation on GDP.

#### 4.5. Do the indicators comparison point out improvements on the last fifteen years?

Figures 10 and 11 show the strategy adopted for answering this question. The color yellow stands for the countries in South Asia, while the color acqua represent the Sub-Saharan African countries. In this case, we wanted to compare three distinct educational indicators in the years 2000 and 2016. Using Parallel Coordinates for this task allows us to find patterns on the data as we interactively query them or reorder their dimensions. Beyond that advantage, they are relatively compact and easy to read once you are familiarized with the data [Heer et al. 2010]. When we presented the parallel coordinates for the group of students, at first they found it hard to interpret, after a short period they comprehended it and captured the message that we wanted to convey.



**Figure 8. Small multiples stacked bar chart of health and education percentual expenditure and GDP growth by region.**



**Figure 9. Small multiples grouped bar chart of health and education percentual expenditure and GDP growth by region.**

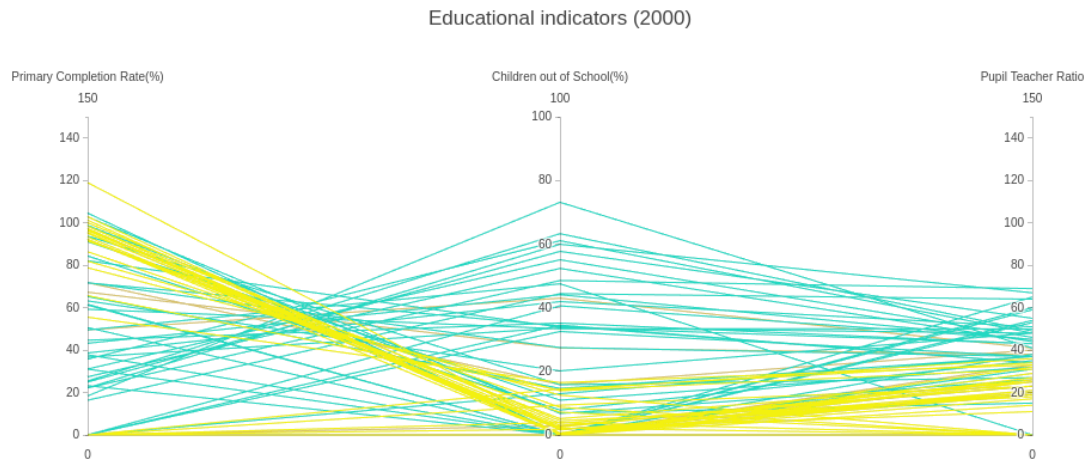
#### 4.6. Have the most critical countries received largest shares of financial assistance?

In order to answer this question, we decided to adopt a bubble chart with the x-axis representing the percentage of population in extreme poverty, the y-axis, the GDP per capita and the size of the bubbles the ODA per capita received by each country (Figure 12). It is reasonable to expect that the largest bubbles lay on the right side of each chart since we assume that the most critical countries, when it comes to population living in extreme poverty and the ones with small GDP per capita are the ones receiving most assistance. Although it seems reasonable, it is not what we witnessed through this analysis. Maybe for two different reasons: first, because we analyze percentual numbers of extreme poverty population and, second, due to other factors driving assistance funds donation. We also adopted the small multiples technique to show the levels of ODA donations every 5 years, since 2000. It is evident that it is growing fast. The group of students took a short period to capture the idea of the chart, but once they analyzed the tooltip we provide for the bubbles, it got clearer and they enjoyed the way we transmitted the information.

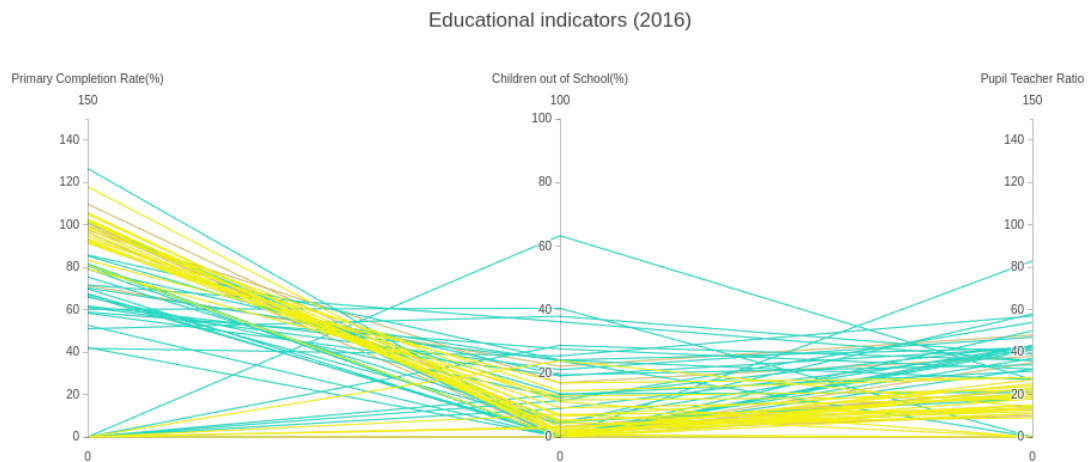
#### 4.7. How are the educational resources distributed from primary to tertiary?

For this chart (Figure 13), we proposed a small multiples grouped bar chart for visualizing how the different South American countries are segmenting their expenditure in education



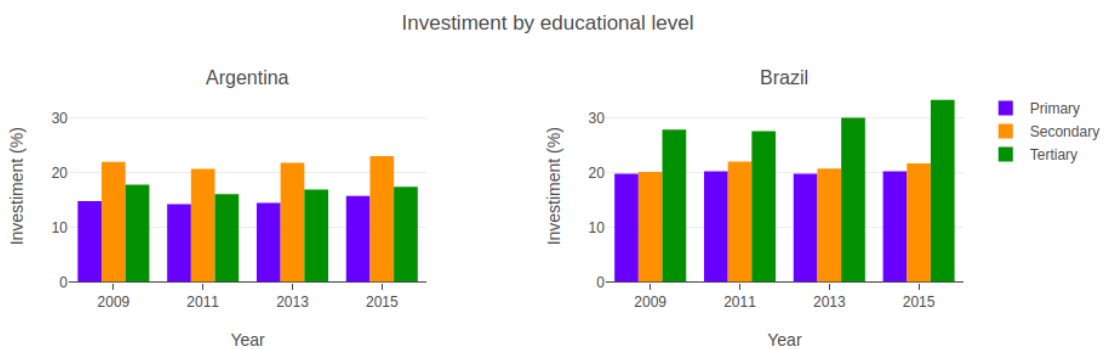
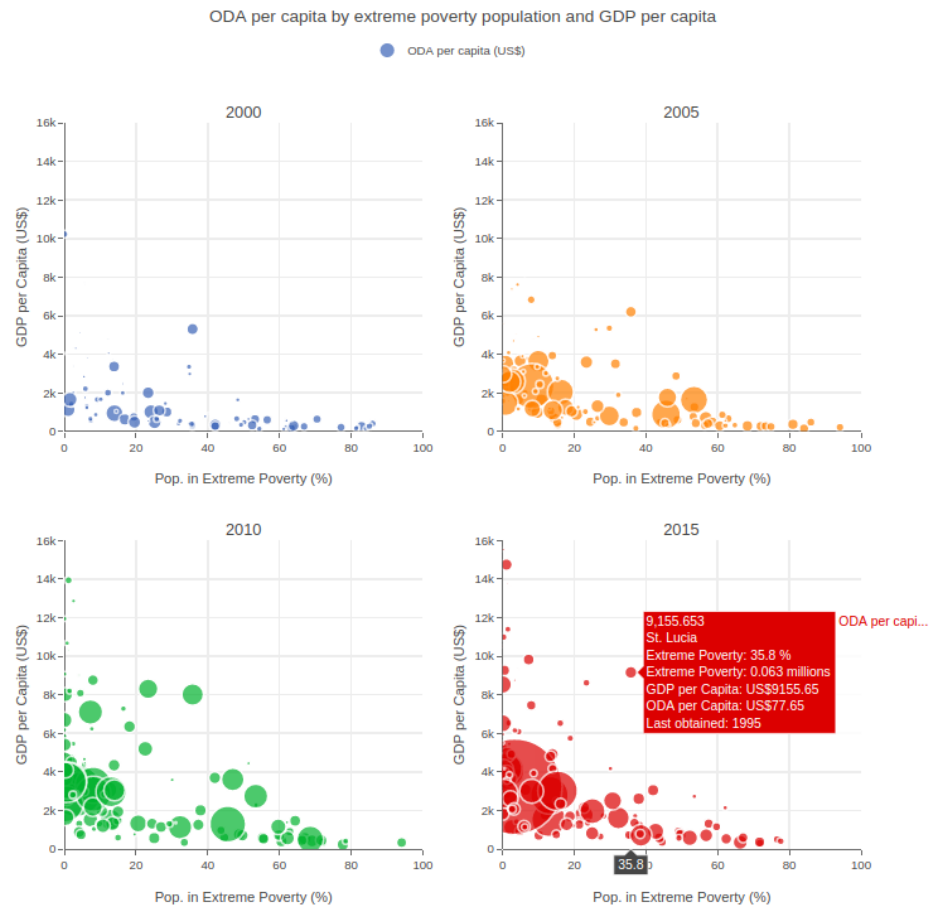


**Figure 10. Sub-Saharan Africa (acqua) and South Asia (yellow) countries evaluation on educational metrics at the year 2000.**



**Figure 11. Sub-Saharan Africa (acqua) and South Asia (yellow) countries evaluation on educational metrics at the year 2016.**

(primary, secondary and tertiary). Analyzing the chart, we easily state that Brazil has been spending more of it is educational expenditure on the tertiary segment, in other words, college education, while Argentina is more concerned with the secondary segment, high school education. The distinguished colors for the levels of education and the same scale on the y-axis for the different small multiple charts facilitate the comparison among the countries assessed by our work. The group of students who analyzed this chart made assertive insights about educational levels expenditure, which led us to believe that the information is clearly conveyed.



## 5. Final considerations

During the development of our work, we explored different visualization techniques, like small multiples, parallel coordinates, bubble charts, etc. We applied them the best way we could for telling the story of how extreme poverty has behaved worldwide throughout the last decades. We hope to have provided our readers with a better understanding of the

current situation of extreme poverty and how we have been evolving on this very delicate issue. We also hope that our insights help develop a critical sense on the readers when it comes to public policy associated with extreme poverty.

The visualization we chose were not always straightforward for the group of students we asked to review. It raises the issue that although we might be comfortable with the visualization, it is always best to ask for a second, third, fourth and as many as possible different opinions and listening to their insights so you can improve the way you transmit the information. Finally, we hope we have contributed to the group of students who helped us with a better understanding of visualization techniques.

## **References**

- Heer, J., Bostock, M., Ogievetsky, V., et al. (2010). A tour through the visualization zoo. *Commun. Acm*, 53(6):59–67.
- Shirley, P. and Marschner, S. (2009). Fundamentals of graphics, third edition. chapter 27, pages 675–707. AK Peters.