Understanding Extreme Poverty and Various Factors Involved with it

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Overview

This prototype is developed to understand extreme poverty around the world/countries and various factors associated with it. The World Bank has introduced various poverty indicators/gaps to define extreme poverty. This tool allows the user to understand the global as well country-wise trend for the extreme poverty indicators and also the relationship between extreme poverty and different factors like GDP per capita, employment and school enrollment.

This tool comprises of a choropleth map, line charts and scatter plots. Map is used for showing the population density living under extreme poverty (mean poverty $1.90 per day), line charts are used to show the global as well as country wise trend of the poverty indicators and scatter plots show the correlation between poverty indicators and the factors mentioned above.

The dashboard is developed using JavaScript libraries, i.e. D3.js, Leaflet, and React. React was used to build the components, D3.js helped to build the line charts and scatter plots and Leaflet used to build the Choropleth map. Data to build the prototype is collected from the World Bank and OECD (The Organisation for Economic Co-operation and Development) open data catalogue.

Introduction

Motivation behind developing this prototype was to get an understanding for Global Extreme Poverty and the various poverty gaps(indicators) defined by the World Bank. This tool also allows to understand the correlation between the different poverty indicators and the factors such as Employment to Population ratio, School Enrollment and GDP Per Capita (international $).

This dashboard is designed to help public policies, economics and sustainability experts, specialist for UN, WHO, World Bank and other development related agencies.

Problem/Domain Questions

Some potential questions that can be answered with the prototype are -

1. Which country has the highest percentage of the population living under extreme poverty?
2. Has extreme poverty changed over the years?
3. How the world's, as well as countries' economy, school enrollment rate and employment to population ratio, are changing over the years?
4. Does extreme poverty depend on school enrollment?
5. Is there any relationship between extreme poverty and employment to population ratio?
6. Does GDP per capita affect nations' or the world's extreme poverty?

Data

Datasets and Host organizations

There are 7 different datasets used in this project and are collected from the World Bank(Data Catalogue) and OECD(Data Catalogue).

Dataset	Source Link
Poverty headcount ratio at $1.90 a day (%of population)	https://data.worldbank.org/indicator/SI.POV.DDAY
Poverty headcount ratio at $3.20 a day (%of population)	https://data.worldbank.org/indicator/SI.POV.LMIC
Poverty headcount ratio at $5.50 a day (%of population)	https://data.worldbank.org/indicator/SI.POV.UMIC
Population living in slums (% of urban population)	https://data.worldbank.org/indicator/EN.POP.SLUM.UR.ZS
School Enrollment Statistics	https://data.worldbank.org/indicator/SE.SEC.ENRR
Employment to Population Ratio (15+, total (%) (modeled ILO estimate))	https://data.worldbank.org/indicator/SL.EMP.TOTL.SP.ZS
GDP Per Capita ($ International)	https://data.oecd.org/gdp/gross-domestic-product-gdp.htm

Dimensions

One important attribute common in all the databases is 'Country Code' that is used to merge all the poverty-related datasets, including population living in slum areas, to create a new poverty dataset.

In all the datasets, there were four main attributes that were used and common to all of them.
1. Country Name
2. Country Code
3. Indicator Name – This attribute has values as below:
    a. School enrollment, preprimary (% gross)
    b. GDP per capita, PPP (current international $)
    c. Employment to population ratio, 15+, total (%)
    d. Poverty gap at $5.50 a day (2011 PPP) (%)
    e. Poverty gap at $3.20 a day (2011 PPP) (%)
    f. Poverty gap at $1.90 a day (2011 PPP) (%)
    g. Population living in slums (% of urban population)
4. Year

Data Cleaning

Value of population percentage column was missing for many cases in the poverty datasets, which were handled by filling them with the mean population percentage for that particular year. In some cases, value for employment percentage and school enrollment percentage was

beyond 100%; these invalid data points were handled while fetching the data into the frontend application.

One more dataset was created with the mean poverty for all the poverty gaps, and this data was used to show the mean poverty distribution for all the countries around on the World map.

Visualization Design

Design Choices and Justification

Map

A World map is used as a spatial reference to show the all the poverty related demographic information. Choropleth map is used to show the mean poverty distribution from 1970 to 2019. Color gradient makes it very easy to find the countries with the most and least population percentage living under extreme poverty. Light color to a dark color gradient scale enables the audience to spot the regions with low and high values quickly. Tooltips are used to communicate the name and the underlying value of poverty stats of each country since they will be hard to read otherwise. Tooltips also work well to remind the audience of which country they have selected. Choropleth are visually compelling - we can see a large amount of information and global patterns for mean poverty. When selecting a country, other areas on the map fades out with grey color, which makes it simpler to remember the selection user has made.

Some other design choice, such as a bar chart, can create a visual clutter as we are dealing with the extreme poverty data across multiple countries over the World. Below screenshot shows the geographical mean poverty distribution in the world. It is evident that the African and Asian regions have the high percentage of population living under extreme poverty than other regions.
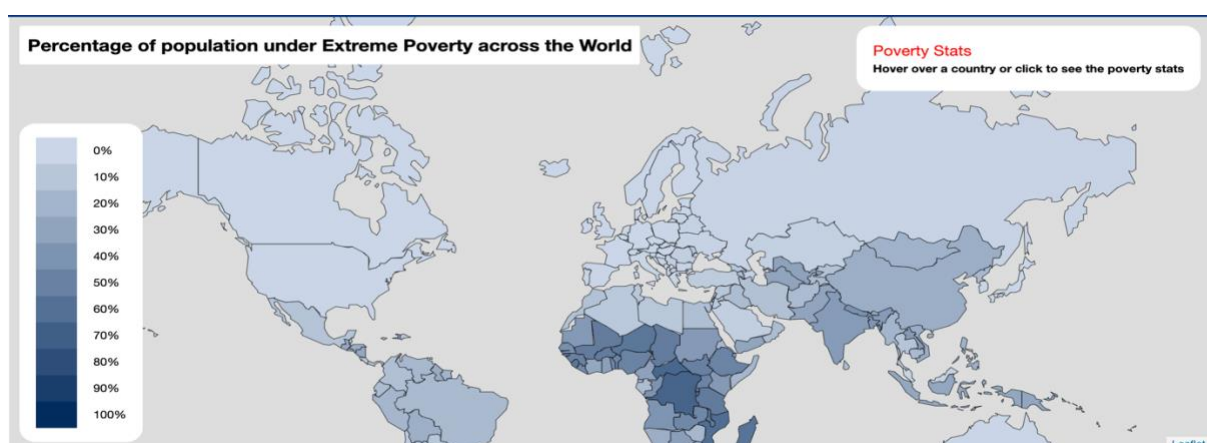

Fig 5.1.1 Mean Global Poverty ($1.90 per day) Distribution

Line Charts

To answer the question, 'Has extreme poverty changed over the years?' the line chart is more intuitive to show population percentage that decreases or increases continuously. The line chart on the extreme left shows the changing trend of poverty gaps over the years (X-axis). Hues are used to show the ordinal variable 'poverty gap' with three different values, poverty gap at $1.90 per day, $3.30 per day and $5.50 per day. Also, population % living in slum areas is shown on the chart with a different hue. It is more straightforward to see that the population living in extreme poverty is decreasing over the years. The two remaining line charts show the changing trend of employment, school enrollment and economy (GDP per capita) over the years. Using the same scale in the charts enable the comparison between poverty and these factors. We can answer the question "How the factors such as employment or school enrollment or GDP are changing over the years with the changing poverty?" using the 2nd and 3rd line charts. All the line charts use the circle-shaped symbols to make the comparison easier in the given year ranges.
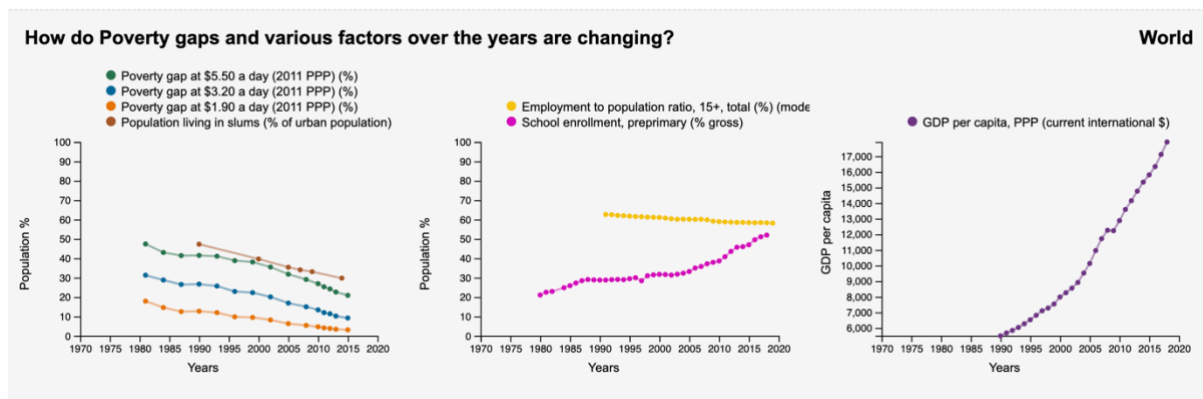

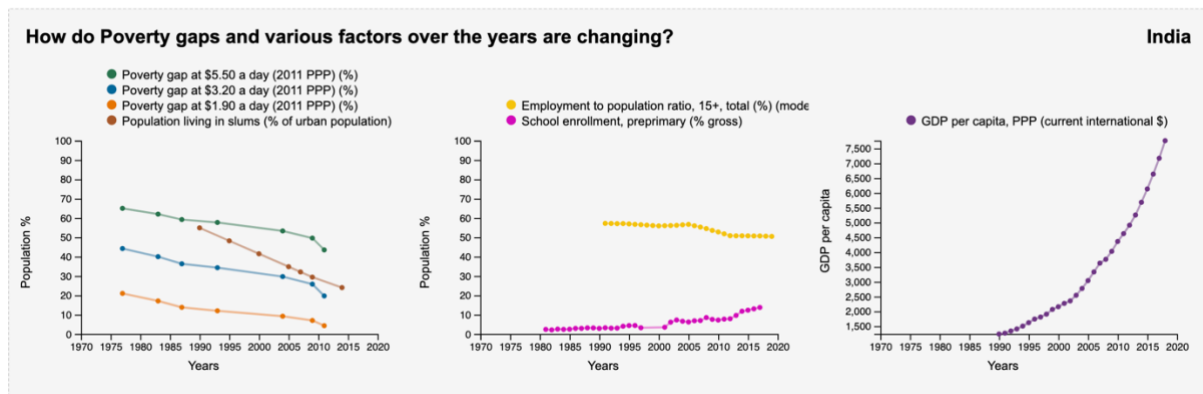Fig 5.1.2 Global Extreme Poverty and other factors over the years

Fig 5.1.3 Extreme Poverty and other factors in India over the years

Scatter Plots

Scatterplots/dot plots were used to find the relationship between a poverty measure and various factors (School Enrollment, employment and GDP per Capita). The colour of the data points in the scatterplot depends on the poverty indicator selected from the line chart that displays extreme poverty trend over the years. The choice of hue for the scatterplot is clear from the

scatterplot's Y-axis value (poverty indicator). Each circle in the scatterplots represent a specific country. Moreover, it gives us details on the population of the country living under a particular poverty gap and also the population, which is enrolled in school or employed, or it provides the GDP per capita of the country. By default, the scatterplots are showing the data for the year 2016 and poverty line $1.90 a day. Using these plots audience can see the relationship between poverty measures and employment, school enrollment and GDP.

Interactions

Filtering and Clicking

Filtering and clicking are applied to the World map and the line chart showing extreme poverty gaps over the years. However, it does not apply to the other line charts and the scatter plots. By default, the tool allows us to see the global view of the extreme poverty distribution and other factors. This filtering is required to switch from global to country-based view. Clicking a country on the World map updates all the line charts and scatter plots with country-specific data. All the line charts show the yearly trend for the selected country and scatter plots highlights that country with a contrasting hue.

Below screenshot shows that Iran is selected on the map.

Fig 5.2.1 World Map showing the country selection

The screenshot below shows all the line charts get updated with the data for Iran from 1970 to 2020.
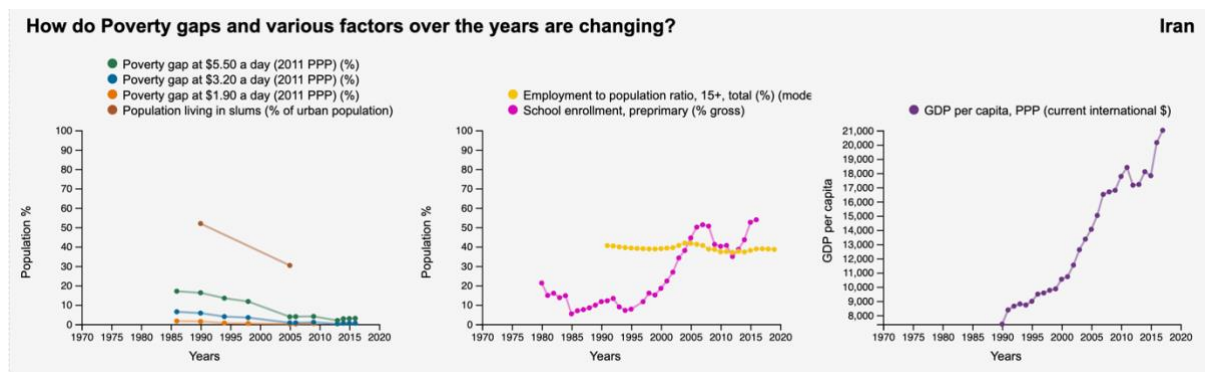

Fig 5.2.2 Line charts showing yearly trends for extreme poverty gaps and other three factors.

The scatterplots below highlight the selected country (Iran) with a red hue and black background.
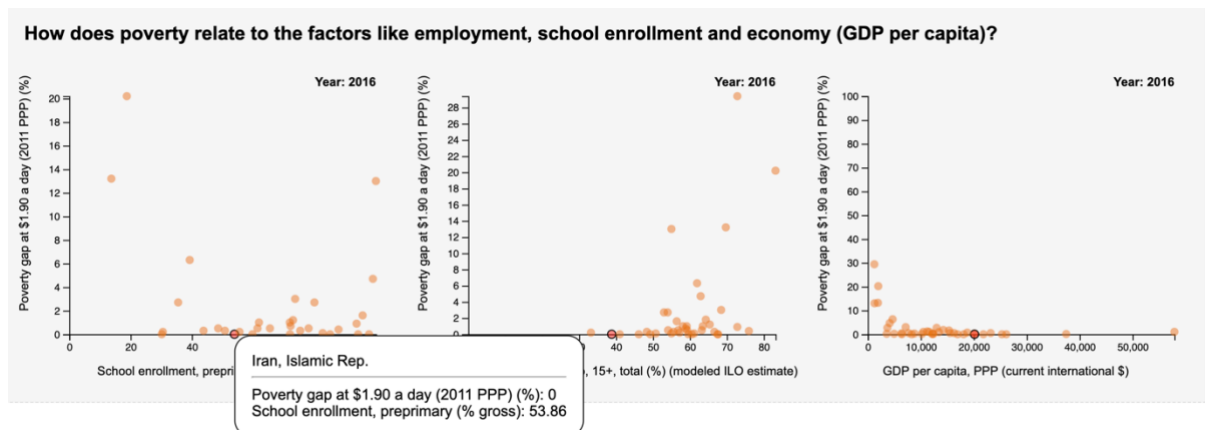

Fig 5.2.3 Scatter plots highlighting the country selected from map

Clicking a data point in the extreme poverty gaps over the years line chart updates the data in the scatter plots, based on the selected year and the poverty gap. The poverty gap and year selection are visible with a red circle with a black background on the line chart.
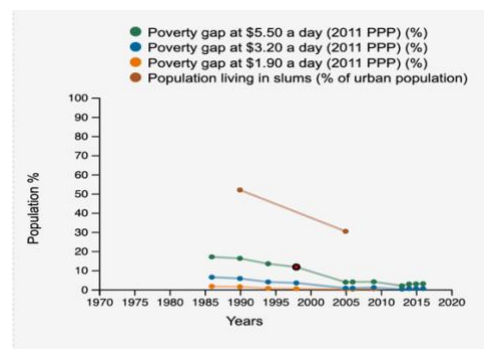

Fig 5.2.4 Line chart for poverty gap at $5.50 a day highlights the data point selected

The scatterplot below updates the data based on the year and the poverty gap selected from the above line chart (poverty gaps vs year) for Iran and also highlights the selected country (Iran) with a red color hue. It helps to observe all the correlation plots for a particular poverty gap and a year.
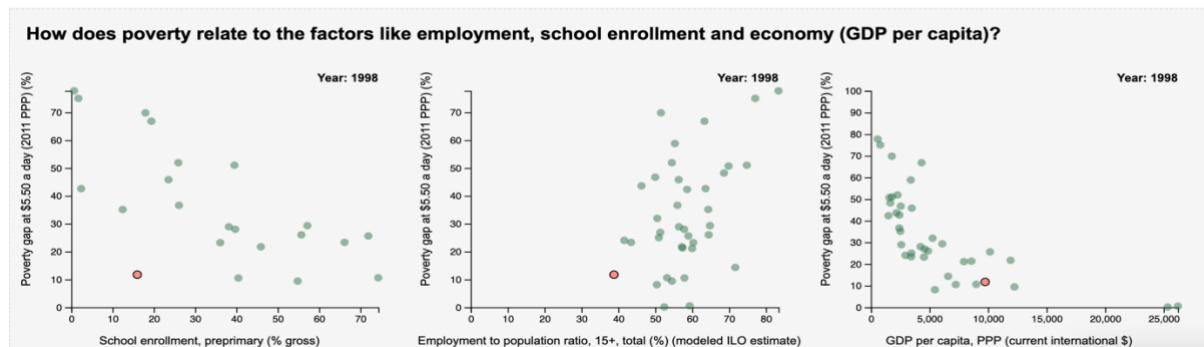

Fig 5.2.5 Correlation plots populated with the data for poverty gap at $5.50 and year 1998

Brushing

All the scatterplot used Brushing. When brushing is applies to select a subset of countries in one scatterplot, all the countries get highlights them with red color. Moreover, we can see the changes in the other scatter plots as well, highlighting the same set of countries. For example, brushing over the bottom right section in the Poverty Gap $5.50 Per Day vs School Enrollment scatter plot (in the screenshot below) where the countries with low poverty and high school enrollment are concentrated, other scatter plots also highlight the same countries. The intention behind using brushing here was to find out if some countries that are low in poverty and are doing very good in a field such as a school enrollment are also the countries with the high GDP per capita or with the high employment rate.
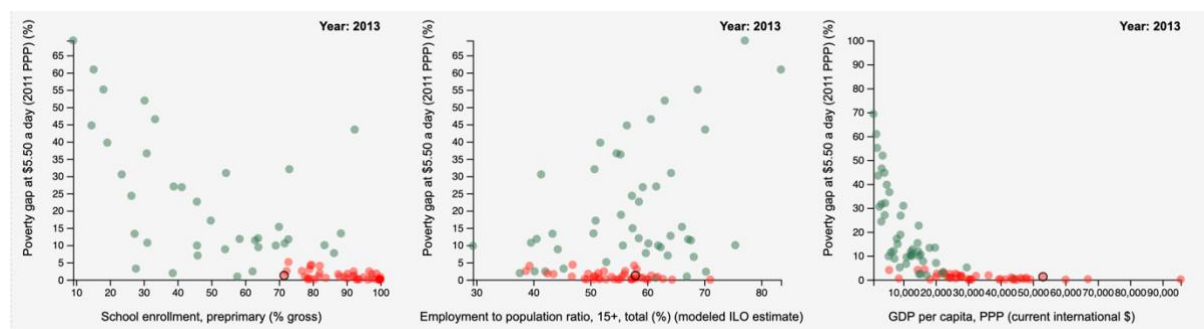

Fig 5.2.6 Brushing in correlation plots

Details on Demand

Details on demand in all visualization designs show an exact detail and also add more richness in the information. Tooltips are used to show the details on demand across the dashboard.

On the World map, hovering over a country shows a detail of the percentage of the population living under different poverty lines - $1.90 per day, $3.30 per day, $5.50 per day and also slum areas. It allows us to comprehend the poverty status of a particular country.

With the first line charts, details are specific to the selected poverty gap or employment or school enrollment or GDP attribute and also includes the year attribute. In the first line chart, it makes it convenient to see the percentage of the population living under extreme poverty for a particular year. Likewise, the second line chart helps us to get the year specific details on the population percentage that are employed and enrolled in school. The third line chart makes us understand the GDP per capita for a particular year.

Scatter plots shows the details such as Country Name, Poverty gap <value> in percentage and the percentage of population enrolled in school or employment to population ratio or GDP per capita in international $.
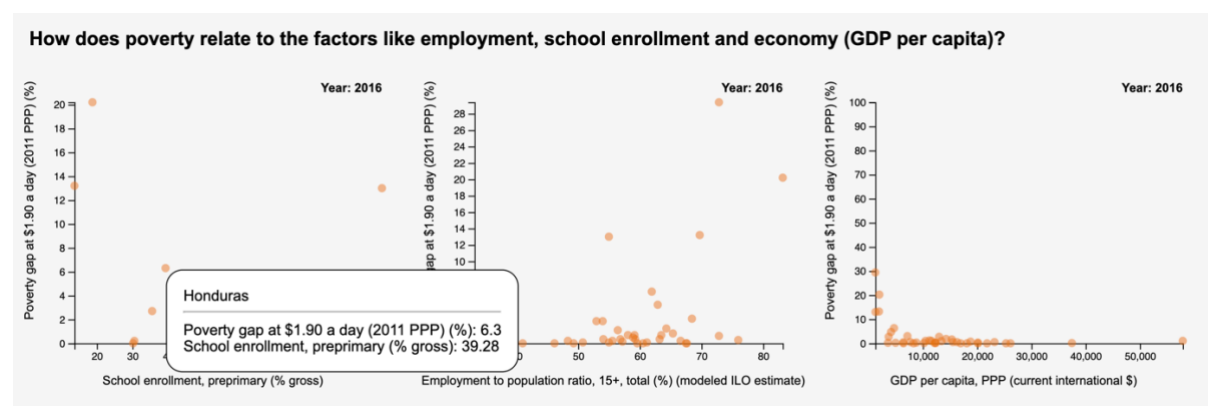

Fig 5.2.7 Tooltips for details on demand

User Manual

The whole interaction starts with the leaflet map, which shows the distribution of the World population living under extreme poverty ($1.90 per day). If a user does not select anything on the map, the dashboard allows seeing the Worldwide view of poverty and its factors.

After clicking a country on the geographic map, all the line charts and scatter plots updates with the country-specific data. On the map, except the selected country, other areas fade out with the grey color, which makes it easier to see the user selection. Tooltip on the top right corner of the map tells the details about poverty stats.

Line Charts shows the country-specific trends for extreme poverty measures, employment to population ratio, school enrollment and GDP per capita over the decades (from 1970 to 2019). Line charts use the circle-shaped symbols to make the comparison easier in the given year ranges. Hovering over a circle in a line shows a tooltip with the poverty gap value in percentage and the year.

In the scatterplots, the selected country gets highlight with a red color, which makes the correlation data easier to understand. Hovering over any data point on scatter plots enables a tooltip which displays the actual stats what the data point is trying to convey.

Clicking the circle symbol on the first line chart (with extreme poverty trend) updates the scatter plot down below with the value of the selected data point. From this chart, user can select a particular poverty gap and a year. This selection updates all the scatterplot and shows correlation between the selected poverty gap and year.

For example, clicking the line chart for poverty gap $3.30 per day and year 2018, update and explain the correlation between poverty gap $3.30 a day and the other factors (employment, school enrollment and GDP per capita) for the year 2018.

In this tool, brushing is used to select a number of the countries (2 or more) in one scatter plot that makes other two scatter plots to also highlights the same set of countries with a red hue. To apply brushing, user needs to make a rectangular selection over datapoints in the scatterplot as below.
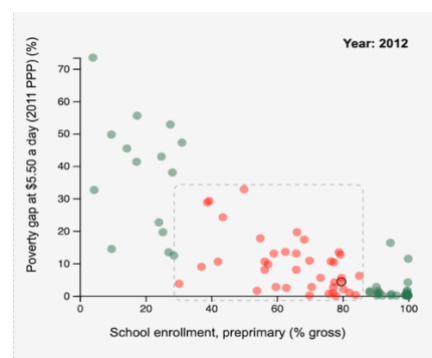

Fig 5.2.8 Brushing with rectangular selection

Prototype Evaluation with Feasibility Pilot

This prototype is useful for the people working in WHO, UN or other public agencies to understand extreme poverty distribution over the years. It is helpful to analyze if extreme poverty is decreased or increased over the years, so they can take essential measures to end this issue by their targeted deadline (the year 2030). After developing the prototype, feasibility pilot was performed with two individuals not from the above expertise.

Some of the issues which were reported were resolved and some can be added in future.

1. Comparing two different countries' poverty stats is not possible with the prototype.
2. When brushing the scatterplots to select a subset of countries, the world map should also be updated with the selection.
3. It was hard to see the scatterplots sometimes with the large Y-axes. So, the axes were changed based on the Y-axis data.
4. It was suggested to add more attributes such as living standards, secondary education and climate change factors.

After the feasibility study, there was not enough time to incorporate all the issues reported above, however second issue was resolved and implemented in the dashboard to reduce the visual clutter.

Future Work

As part of the future work, more filtering and brushing can be added in the visualization dashboard to make it fully interactive. Another area of improvement is to enable the comparison of two countries which was not possible with the current implementation due to time constraints. More factors, such as Secondary Education, Living Standards, Climate Change and Lack of infrastructure, can be incorporated into the dashboard to understand their relationship with poverty. As the World Bank is planning to end the extreme poverty by 2030 by developing many projects around the world and specific to countries and provinces. The project distribution can also be shown in the dashboard using a leaflet map. Moreover, annotations can be added in the line charts to highlight some interesting points to help gather the attention of the audience.

Conclusion

This visualization tool helps the audience to analyze the extreme poverty distribution worldwide as well as country-wise and also the factors influencing it and also allows them to see their relationships. It comprises a map, line graphs, and scatter plots. The visual design was a success in answering the potential questions asked at the beginning of the project because of the design choices made for the project. The map is used to show the population density living under extreme poverty also gives us the freedom to select a country to switch from global to a country-wide view of the dashboard. Line charts are significant in explaining the poverty, employment, school enrollment and GDP trend over the years. Whereas, scatterplots play a crucial role to help the audience to understand the correlation between extreme poverty and different measures. Some important future improvements that would implement are to enable the poverty comparison between two or more countries and also to show the distribution of the project the World Bank has developed to help the countries to end the extreme poverty.

Prototype
Visualization dashboard is available here.

Code Repository
Link for the GitHub repo is here.

Video Link
Link for the video repo is here.

References

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7. Buliding responsive charts with React and D3 V4, Kacper Goliński, Dec 2016