PURDUE UNIVERSITY | Mitchell E. Daniels, Jr. School of Business

Visual Analytics
Session 11:30- 13:00
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Food Insecurity

Group 1

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Introduction and background

The goal of the project is to examine food insecurity statistics and analyze the underlying causes. The data analyzed is from 2000 to 2022 worldwide.
Food insecurity has been a recurring challenge throughout human history. In the 21st century, the problem of food insecurity remains persistent, even as global food production has reached unprecedented levels. The reasons for this paradoxical coexistence of abundance and scarcity are multifaceted and deeply interconnected. Climate change, inflation, population growth, pandemics, income inequality, and geopolitical conflicts all contribute to the prevalence of food insecurity in various regions around the world. (Hiral Patel, Barclays, 2023)
Studying food insecurity and relating it to human activities of 21st century. Correlating food insecurity with various factors like a country's GDP per capita, population growth, impact of the pandemic, income inequality, and COVID (Food Security Information Network, 2023).

Datasets

This project uses 6 data sets: GDP per Capita, Food Insecurity, Income Inequality, World Population, COVID, and Average Food Price.

- GDP per Capita: Published and collected by International Monetary Fund (IMF), this data set shows the GDP per capita for each country. This is an important and basic indicator which is commonly used in government reports and economic research. Extracting from the original IMF dataset, this sub-dataset used contains GDP per capita each year for 266 countries/areas/regions from 2000 to 2022. (International Monetary Fund, 2023)

- Food Insecurity: Since the concept of 'food insecurity' is relatively new, we are taking dataset of 'percentage of population undernourishment' collected by FAO from official data published by each government as indicator for food insecurity. The dataset shows 3-year average of percentage of population undernourishment for 196 countries/areas/regions from 2002 to 2022. (Food and Agriculture Organization of the United Nations, 2023)

- Income Inequality: Published and collected by OECD to show the income inequality of the member countries. The dataset shows index of inequality, ranging between 0 in the case of perfect equality and 1 in the case of perfect inequality for 45 countries from 2000 to 2021. (Orgnisation for Economic Co-operation and Development, 2023)

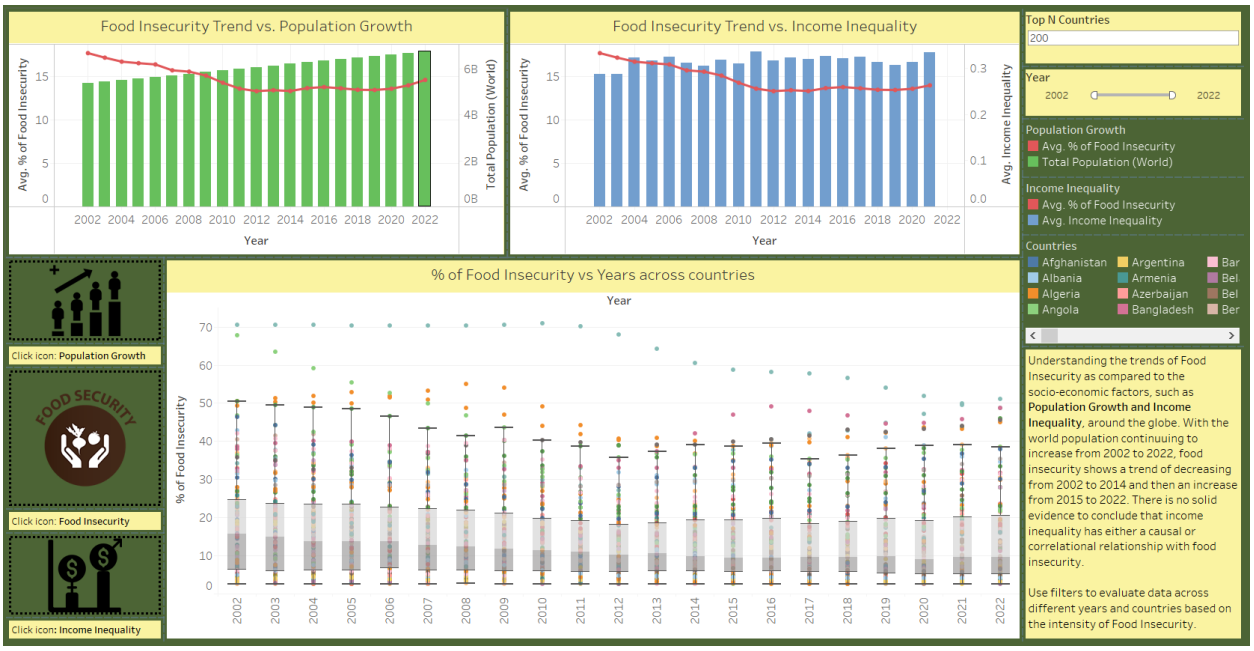
- World Population: Collected and self-funded by The World Bank, this dataset shows the world population for each country. This is an important and basic indicator which is commonly used in government reports and The World Bank annual report. Extracting from the original dataset, the dataset used contains world population of each year for 196 countries (sometimes sub-categorised as areas/regions in the dataset) from 2000 to 2022. (The World Bank, 2023)

- COVID: Collected by WHO from each government official reports. This dataset shows the accumulated COVID cases of 196 countries (sometimes sub-categorised as areas/regions in the dataset) from 2019 to 2023. (World Health Organization, 2023)

- Average Food Grain Price: Published and collected by OECD to show the price of commodities, such as corn and maize in the member countries. The dataset shows index of major food price for 54 countries from 2015 to 2021. (Orgnisation for Economic Co-operation and Development, 2023)

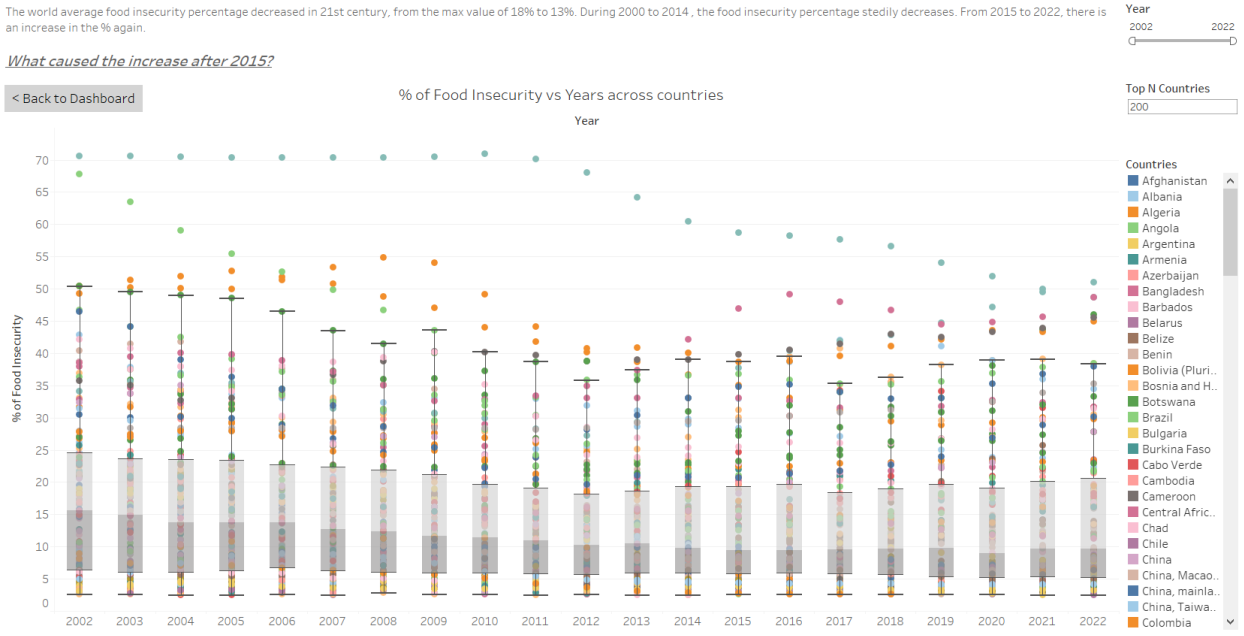
Data Story

This project consists of three main components: the overarching trend in food insecurity during the 21st century, the correlation between major events and food insecurity rates, and the relationship between economic indicators and food insecurity. Our objective is to grasp the overall food insecurity rate trend, using it as the foundation for assessing the hypothesis that 'major events (e.g., COVID) and economic factors impact food insecurity rates.'



Dashboard 1 - % of Food Insecurity vs Years, Population, and Income, across countries

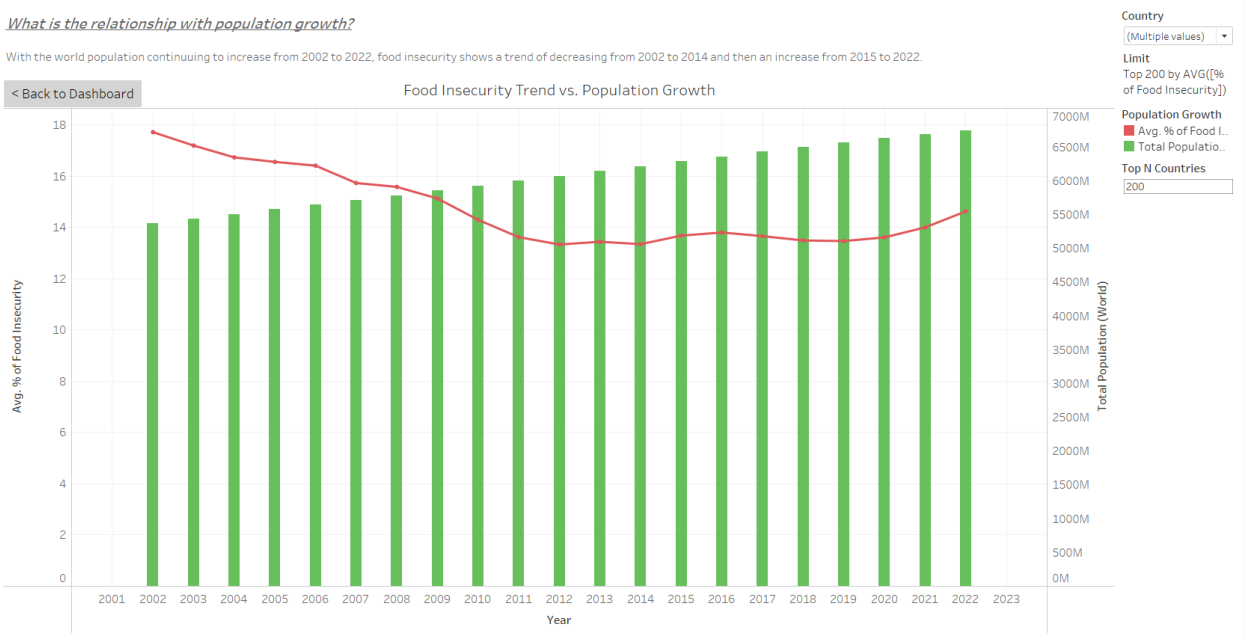
To comprehend the overall trend, we initially generate a boxplot depicting the distribution of food insecurity rates across various countries from 2000 to 2022, as illustrated in *'Overall Trend: % of Food Insecurity'*.



Overall Trend - % of Food Insecurity vs Years across countries (Boxplot)

The above visual representation is constructed using data from the FAO's Food Insecurity dataset, employing the variables 'Year,' '% of Food Insecurity,' and 'Country.' Its purpose is to depict each country as a data point on the chart while allowing for the selective focus on specific periods in the 21st century.
Utilizing a boxplot, we discern a prevailing trend in the decreasing food insecurity rate throughout the 21st century. Notably, the median decreases from 15.65 to 9.70. Somalia exhibits the highest food insecurity percentage between 2002 and 2021, plummeting from 70.6% to 49.9%, with Madagascar topping the list in 2022 at 50.1%.

Before delving into the analysis of the factors influencing fluctuations in the food insecurity rate, it is crucial to establish an appropriate baseline for food insecurity rates. Thus, it becomes imperative to craft a line chart illustrating the world's average food insecurity rate from 2002 to 2022. Concurrently, the composite chart below also scrutinizes the interplay between population growth and food insecurity by comparing it with the global population. To build this chart, we draw upon data from the FAO's Food Insecurity dataset, utilizing 'Year,' 'Country,' and '% of Food Insecurity,' while complementing it with 'Total' (Total population) data from the World Bank's Population dataset.



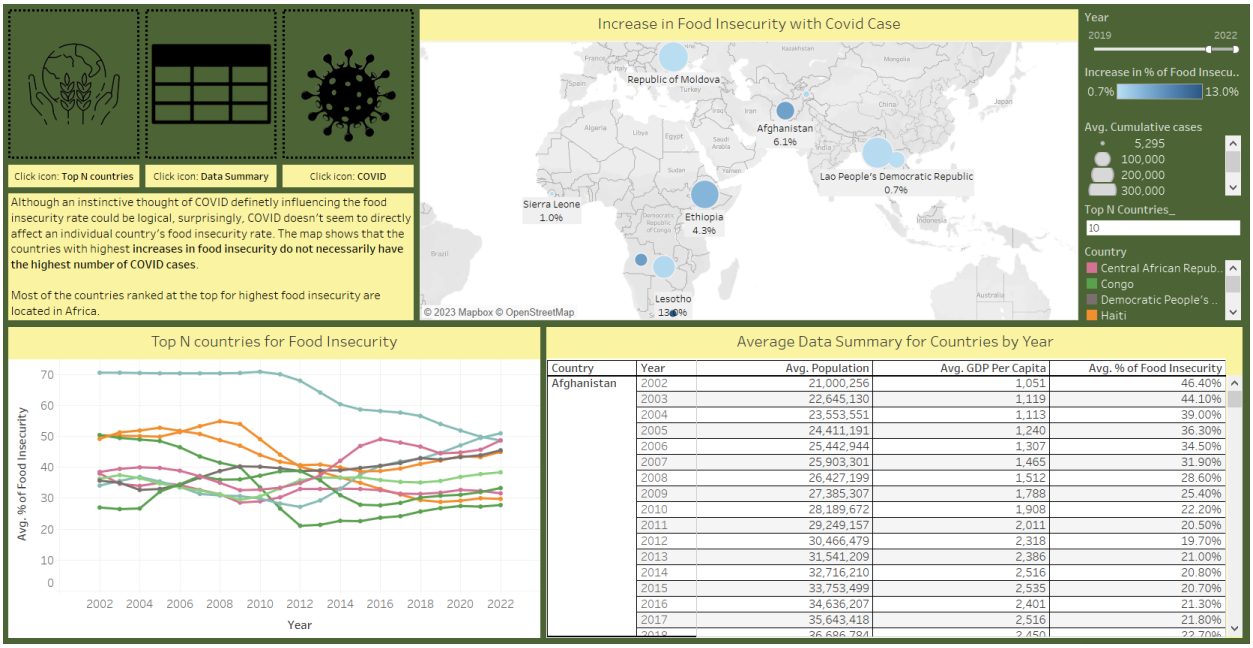
Overall Trend - Food Insecurity Trend with Population Growth (Bar and Line)

The food insecurity line presented in the chart represents the global average, signifying a decline in the world's food insecurity rate throughout the 21st century. The average food insecurity rate decreases from 17.71% to 13.99%, reaching a low of 13.33% in 2012, with subsequent slight fluctuations.
When we juxtapose this food insecurity trend with the world population, we observe a consistent global population growth that doesn't significantly impact the decline in food security from 2002 to 2012. This observation challenges the assumption that the high population growth is a primary driver of changes in food insecurity rates.

Following our examination of population, the next query pertains to the potential impact of income inequality on food insecurity rates. GDP reflects a country's purchasing power, while individual income signifies personal purchasing power. Nevertheless, the chart below does not align with this assumption,

suggesting that personal income, in comparison to a country's economic situation, has a relatively minor influence on food security rates.
To construct this chart, we draw upon data from the FAO's Food Insecurity dataset, employing '% of Food Insecurity' and 'Year,' in conjunction with 'Value' data from the OECD's Income Inequality dataset. The measure of income inequality ranges from 0, representing perfect equality, to 1, representing perfect inequality.

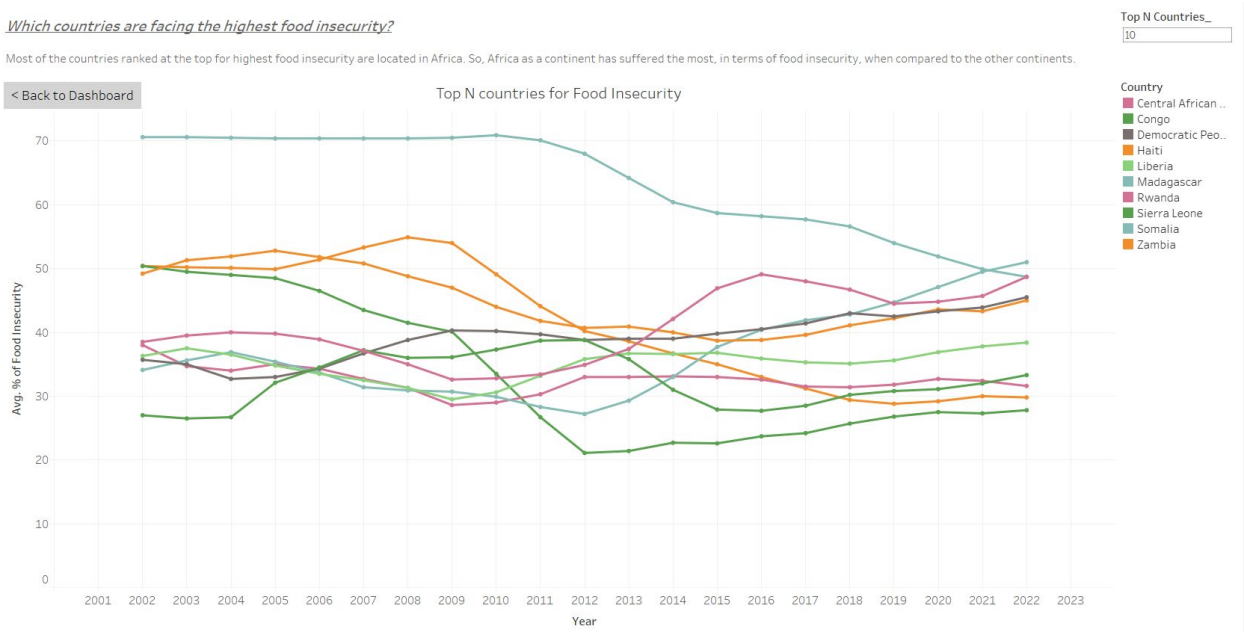
Economic - Food Insecurity Trend with Income Inequality (Bar and Line)



Country	Year	Avg. Population	Avg. GDP Per Capita	Avg. % of Food Insecurity
Afghanistan	2002	21,000,256	1,051	46.40%
	2003	22,645,130	1,119	44.10%
	2004	23,553,551	1,113	39.00%
	2005	24,411,191	1,240	36.30%
	2006	25,442,944	1,307	34.50%
	2007	25,903,301	1,465	31.90%
	2008	26,427,199	1,512	28.60%
	2009	27,385,307	1,788	25.40%
	2010	28,189,672	1,908	22.20%
	2011	29,249,157	2,011	20.50%
	2012	30,466,479	2,318	19.70%
	2013	31,541,209	2,386	21.00%
	2014	32,716,210	2,516	20.80%
	2015	33,753,499	2,535	20.70%
	2016	34,636,207	2,401	21.30%
	2017	35,643,418	2,516	21.80%

Dashboard 2 – Top N Food Insecure countries, Covid pandemic, and Data summary

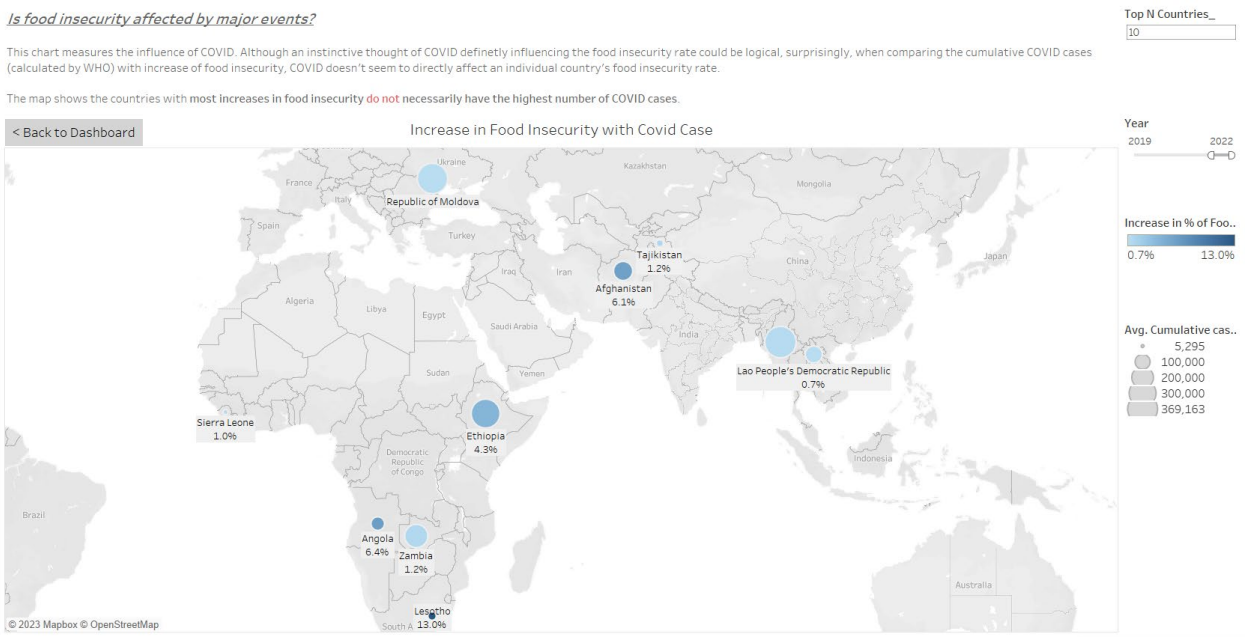
We delve deeper into the countries experiencing the most acute food insecurity by generating the chart 'Overall Trend - Top N countries for Food Insecurity (Line).' This visualization is constructed using 'Year,' '% of Food Insecurity,' and 'Country.' The selection of the Top N countries is determined by the cumulative food insecurity rates from 2002 to 2022 for each nation. The chart showcases the countries with the highest food insecurity rates, with users having the flexibility to define the value of N from 2002 to 2022. All the data utilized is sourced directly from the FAO's Food Insecurity dataset or derived from it.



Overall Trend - Top N countries for Food Insecurity (Line)

Upon scrutinizing the food insecurity rates in the most afflicted nations, a noteworthy observation emerges: the trends exhibit fluctuations and curvatures, with certain countries experiencing an upsurge in food insecurity rates when comparing 2022 to 2002.
It's noteworthy that the Top 10 countries with the highest food insecurity percentages are all categorized as either developing countries or the least developed countries by the United Nations (United Nations, 2023). These low development countries typically exhibit characteristics such as high birth rates, high mortality rates, and underperforming economies. This raises a pertinent question: Is there a correlation between a specific country's economic status and its food insecurity rate?

Illustrating the impact of recent global events, we examine the relationship between the cumulative COVID-19 cases in each country and the corresponding increase in food insecurity rates over a specific period.
The chart employs data elements like 'Year,' 'Country,' and 'Increase in %,' calculated based on the '% of Food Insecurity' from the FAO's Food Insecurity dataset, in conjunction with 'Cumulative cases' data from the WHO's COVID dataset. The visualization applies a Top N filter to identify and analyze the N countries with the most significant increase in food insecurity percentages from 2019 to 2022. The intensity of coloration within the chart indicates the magnitude of increase in food insecurity percentages, while the size of the blobs represents the cumulative COVID-19 cases, with larger blobs signifying higher case counts.



Major Event - Increase in Food Insecurity with Covid Case (Map)

Nevertheless, the chart does not demonstrate a clear positive correlation between cumulative COVID-19 cases and the rise in food insecurity percentages. In a positive relationship scenario, one would expect to observe larger blobs with darker colors and smaller blobs with lighter colors on the map. Consequently, it's not reasonable to conclusively assert that major global events have a direct impact on food insecurity rates. This prompts us to question whether food insecurity rates are indeed connected to economic indicators.

For an in-depth exploration of individual countries, users are furnished with a crosstab display, revealing food insecurity rates, population figures, and GDP per capita, organized by country and year. This data is sourced from the FAO's Food Insecurity dataset, the World Bank's World Population dataset, and the IMF's GDP per Capita dataset.

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Average Data Summary for Countries by Year

Country	Year	Avg. Population	Avg. GDP Per Capita	Avg. % of Food Insecurity
Afghanistan	2002	21,000,256	1,051	46.40%
	2003	22,645,130	1,119	44.10%
	2004	23,553,551	1,113	39.00%
	2005	24,411,191	1,240	36.30%
	2006	25,442,944	1,307	34.50%
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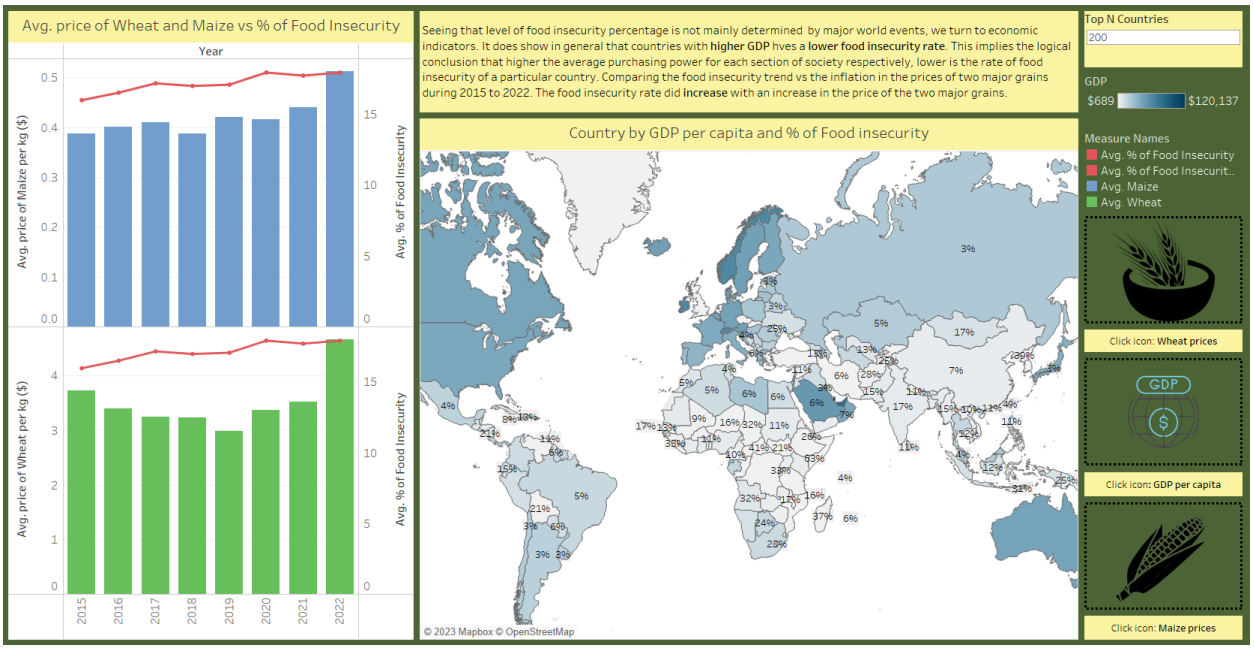
	2013	31,541,209	2,386	21.00%
	2014	32,716,210	2,516	20.80%
	2015	33,753,499	2,535	20.70%
	2016	34,636,207	2,401	21.30%
	2017	35,643,418	2,516	21.80%
	2018	36,686,784	2,450	22.70%
	2019	37,769,499	2,543	24.00%
	2020	38,972,230	2,459	26.90%
	2021	40,099,462		28.80%
	2022	41,128,771		30.10%
Albania	2002	3,051,010	5,149	4.90%
	2003	3,039,616	5,561	6.00%
	2004	3,026,939	6,051	7.40%
	2005	3,011,487	6,619	8.60%
	2006	2,992,547	7,272	8.90%
	2007	2,970,017	7,975	8.80%
	2008	2,947,314	8,805	8.30%
	2009	2,927,519	9,221	7.40%
	2010	2,913,021	9,726	6.10%
	2011	2,905,195	10,208	5.40%
	2012	2,900,401	10,526	4.80%
	2013	2,895,092	10,571	4.50%
	2014	2,889,104	11,259	4.40%
	2015	2,880,703	11,662	4.40%
	2016	2,876,101	12,078	4.30%
	2017	2,873,457	13,040	4.20%

Top N Countries
200

Country
(All)
Afghanistan
Albania
Algeria
American Samoa
Andorra
Angola
Antigua and Barbuda
Argentina
Armenia
Australia
Austria
Azerbaijan
Bahamas
Bahrain
Bangladesh
Barbados
Belarus
Belgium
Belize
Benin
Bermuda
Bhutan
Bolivia (Plurinational ...
Bosnia and Herzegovina
Botswana
Brazil

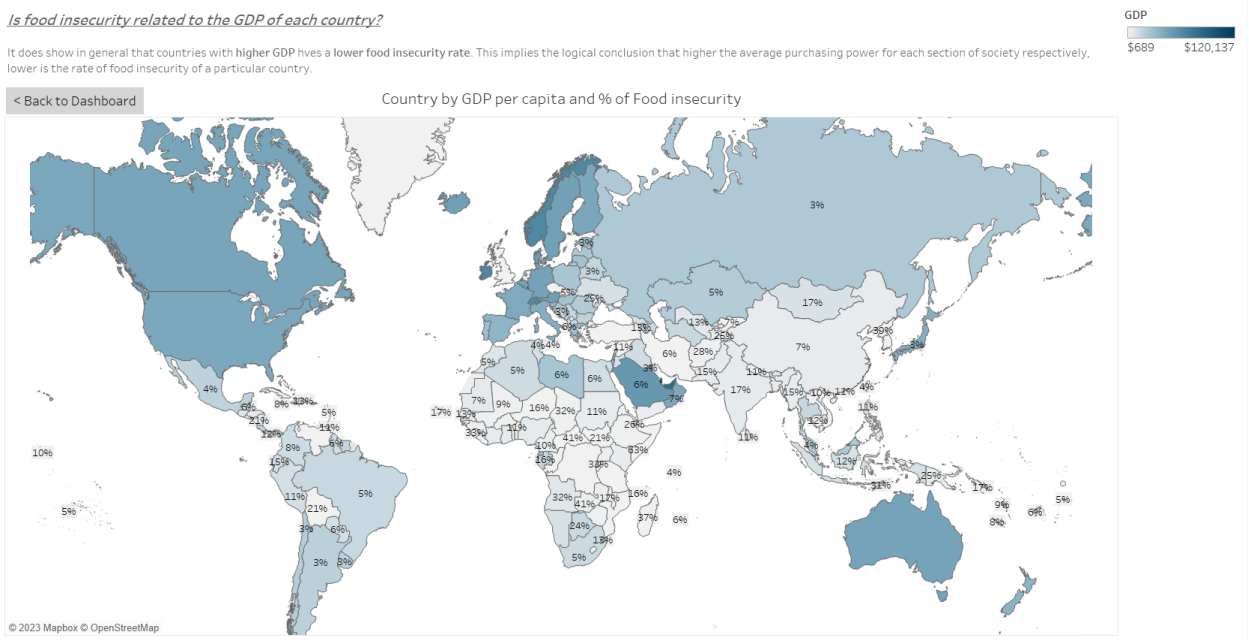
Limit
Top 200 by AVG([% of Food Insecurity])

Reference - Country Average Data by Year (Crosstab)



Dashboard 3 – Major food grain prices and Average GDP by country

To address the inquiry regarding the correlation between food insecurity rates and economic indicators, we adopt a broad method by computing the average 'GDP per capita' from 2002 to 2022 and contrasting it with the average '% of Food Insecurity' from 2002 to 2022 for each individual country. These data points are sourced from the FAO's Food Insecurity dataset and the IMF's GDP per Capita dataset.

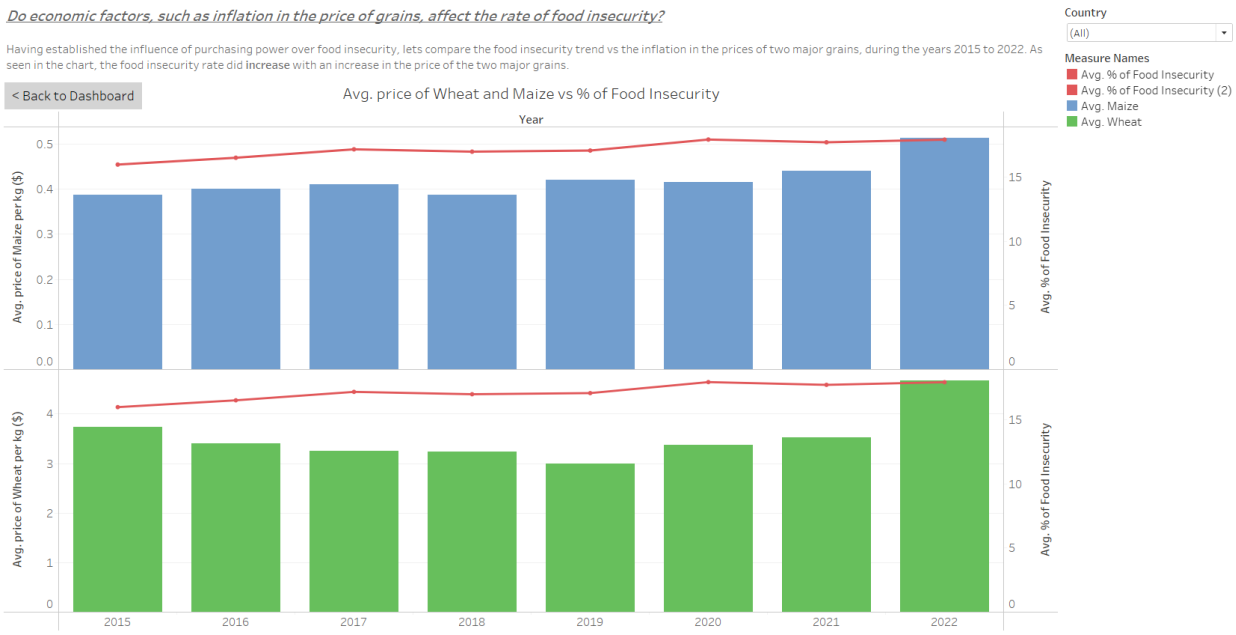


Economic - Country by GDP and % of Food insecurity (Map)

Countries boasting a high average GDP per capita are depicted with a deep shade, and the map illustrates the corresponding average food insecurity rate within each region. A general trend emerges from this visualization, indicating that countries with elevated GDP per capita tend to exhibit lower levels of food insecurity.

While it's clear that a country's economic status influences food insecurity rates, this alone doesn't elucidate the rising trend in food insecurity rates beyond the first decade of the 21st century. Therefore, we turn our attention to a counter factor, the cost of key food commodities.

The chart utilizes data from the OECD's Average Food Price dataset, encompassing 'Wheat' and 'Maize,' alongside 'Year,' 'Country,' and '% of Food Insecurity' from the FAO's Food Insecurity dataset. This visualization empowers users to explore the per-kilogram prices of maize and wheat in specific countries while comparing them to their respective food insecurity rates. Additionally, it offers options to scrutinize the global food insecurity trend in conjunction with the average world prices of wheat and maize. Notably, the escalating world average prices of these grains since 2015 may elucidate the upswing in food insecurity rates.



Economic - Avg. price of Wheat and Maize vs % of Food Insecurity (Bar and Line)

Summary and Conclusions

In the 21st century, the global average food insecurity rate has experienced a significant decline. However, countries grappling with severe food insecurity continue to endure, with their average food security rates often four times higher than the world average. These nations still exhibit abrupt fluctuations in food insecurity rates.

Economic well-being primarily shapes the food insecurity rate in each country, and it does not definitively establish a direct link between major events and food insecurity rates. The post-first-decade increase in the world's average food insecurity rate can be attributed to the rising costs of staple cereals, and this influence persists to the present day.

Contributions

Chun-Yi Chiang conceived of the presented idea. Shubhankar D Bhajekar created the Tableau dashboards. Abhishek Krovvidi, Aravind Teja Chikoti, Chun-Yi Chiang, and Shubhankar D Bhajekar developed the theory, performed the computations, cleaned the dataset, and created visuals on Tableau. All authors discussed the results and contributed to the final manuscript.