Macroeconomic Indicators - Global and US impact analysis

Data 602

Final Project

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Understanding various economic indicators globally, regionally and how they impact the average consumer.

Abstract

In order to better understand the prices of consumer goods and what economic factors contribute to them. This study took economic data -- the global consumer price index (CPI), supply chain index (GSCI), gross domestic product (GDP) per capita, gross national income (GNI) per capita, interest rates, and inflation rate -- loaded from several sources such as World Integrated Trade Solution, International Monetary Fund, Federal Reserve Bank of New York, Board of Governors of the Federal Reserve System, World Bank, and US Department of Labor Statistics. Additionally, real median income data for the United States was downloaded from Federal Reserve Bank of St. Louis. Statistical analysis, trends, and correlations were studied by our group utilizing python on google collab. The data was downloaded into python and subsequently transformed, cleaned, tidied, and merged in order to research the complex relationships between these economic factors. All economic factors were studied globally and by country with a focus on the United States. Globally, there are strong correlations between CPI and inflation rate. For the US, there are several correlations between GNI/GDP and household income, CPI and supply chain pressure index, inflation rate and CPI, CPI and GNI/GDP. Weaker correlations exist between inflation rate and household income, and interest rates and household income. There is a significant difference between the GDP vs GNI per capita for Luxembourg and Japan. Japan has higher GNI compared to GDP from exports and Luxembourg has lower GNI to GDP due to high imports. The high correlations may suggest the economic factors at play that are contributing to high prices.

Agenda

1 Project overview

2 Data Collection

3 Data Cleansing

4 Exploratory Analysis

5 Findings

6 Conclusions

Project Overview

We analyzed the following key indicators -- **Global CPI, inflation rate, interest rates, GSCPI, GDP per capita, and GNI per capita** -- from 2014 to 2022 to uncover trends and patterns across global and regional markets.

Metric Definitions

Consumer Price Index (CPI):
Average change in consumer good prices. An important metric for gauging purchasing power and international competitiveness.

Inflation Rate:
Percentage increase in cost of goods and services. Excess inflation is a sign the economy is overheating while low inflation can be a harbinger of economic recession.

Interest Rates:
Set by central banks, Interest Rates influence borrowing costs and investment decisions, impacting global capital flow.

Global Supply Chain Pressure Index:
A monthly index that measures the severity of global supply chain disruptions.

Gross Domestic Product (GDP) per capita:
Measures overall economic output of a nation, indicating growth or contraction which can impact trade flows and investment decisions.

Gross National Income (GNI) per capita:
The GDP of a nation plus the money earned on exports minus the capital spent on exports. GNI essentially represents the average income per person in that nation.

Project Overview

1. **Relationship Between CPI and Inflation Rate**
   - **Hypothesis**: *Is there a strong correlation between Consumer Price Index (CPI) and inflation rate, and how consistent is this relationship over time?*
2. **Impact of the Global Supply Chain Pressure Index (GSCPI)**
   - **Hypothesis**: *Does the Global Supply Chain Pressure Index (GSCPI) significantly affect inflation rates and CPI, particularly during global economic disruptions?*
3. **Correlation Among Global Indicators (2014–2022)**
   - **Hypothesis**: *Is there a statistically significant correlation between global indicators—CPI, inflation rate, interest rates, GSCPI, GDP per capita, and GNI per capita—from 2014 to 2022?*
4. **United States-Specific Analysis**
   - **Exploration**: *In the United States, how do household income trends interact with CPI, inflation rate, and other global indicators like GDP per capita, GNI per capita, and GSCPI?*
   - **Hypothesis**: *Does rising inflation significantly impact the prices of consumer goods over time, if so, which categories of goods are most affected?*
   - **Hypothesis**: *Where do commodity prices fluctuate the most, and are these fluctuations linked to inflationary trends or other global economic indicators?*

Data Collection

The challenges surrounding data collection involved finding the right source, downloading data in a legible format, and consolidating it into a single repository. Ultimately, we wanted to use a single dataframe for our exploratory and statistical analysis.

DATA SOURCES:

Global CPI data for all countries from International Monetary Fund(IMF):
USA CPI data by expense categories/commodities:

CPI Data

Inflation Rate from World Bank

Inflation Data

Supply Chain Pressure Index:

SCPI Data

Interest Rates:

Interest Data

GDP per Capita, GNI per Capita, and US Household Income from US Department of Labor Statistics:

Income Data
GDP and GNI Data

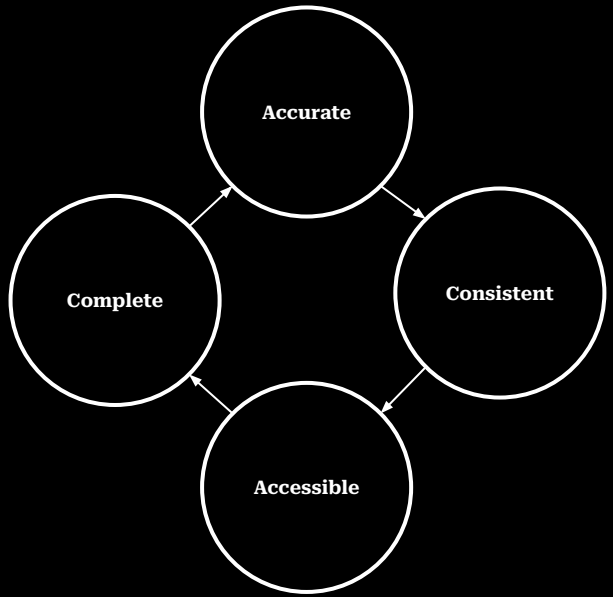
Data Cleaning

Data Cleaning Process

- Renaming columns, dropping NA rows, pivoting raw data to long format
- Replacing values to cleansed format, removing unwanted text in columns
- Filtering data to 2014 onwards
- Aligning Country names (consistent spelling across dataframes)
- Extracting month and year
- Interpolating to monthly data and aggregating by year
- Changing data types and decimals for all indicators to common format
- Sorting values and ensuring data frames retain columns of interest

Data Merging Process

- Merged CPI data frame with Inflation Data frame (Country level)
- Merged above data frame with Interest Rates data frame
- Merged above data frame with GSCPI data frame (not at country level)
- Merged above data frame with GDP and GNI data frame (Country level)
- Merged above data frame with household income data frame (USA only)



Data Cleansing - Challenges

Given the number of datasets included in this analysis, we bumped up against a number of challenges when normalizing the data, to ensure comparability across metrics.

01

Daily data -> monthly -> yearly aggregation.

Standardizing

02

Merging dataframes in various formats. Matching by year and by country ensuring consistency across data types.

Merging

03

Aligning on country names, handling missing country values, and ensuring consistent spelling across to maximize countries captured.

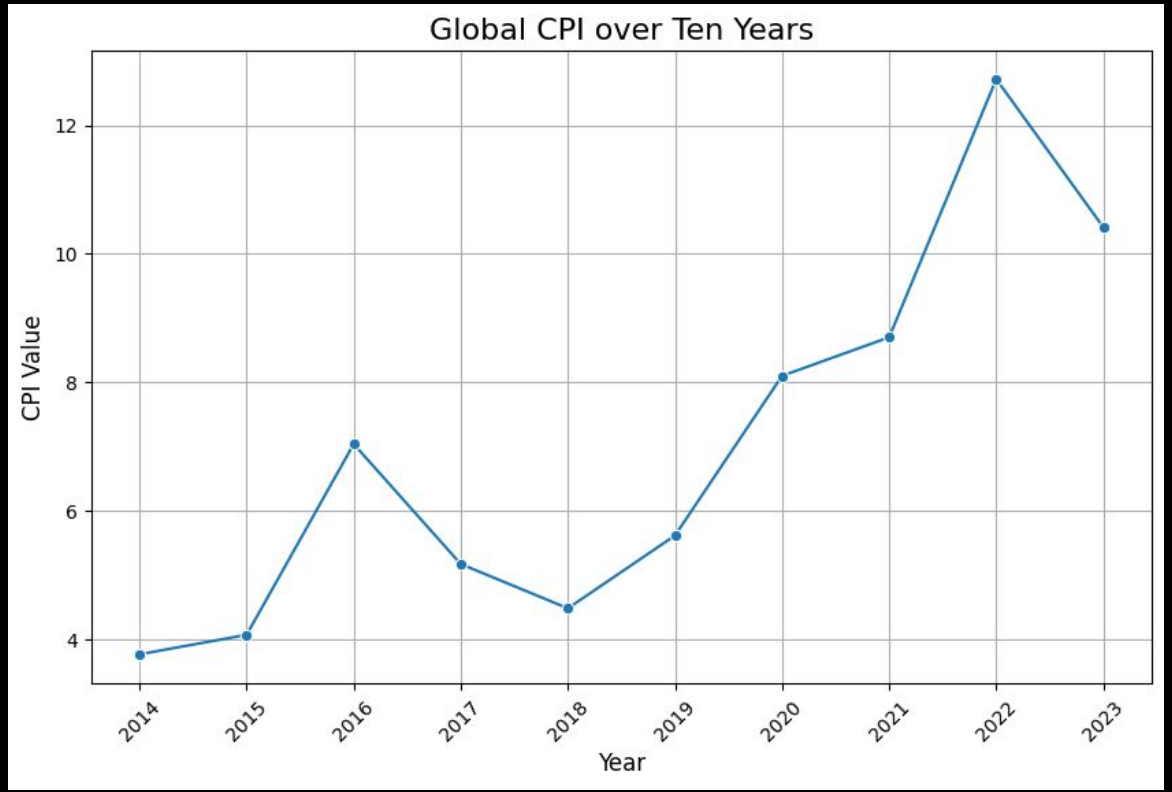
Transformation

Exploratory Analysis

Pre-Pandemic Trends (2014–2019):
Global CPI increased in 2016 due to commodity price volatility, especially in energy and food markets.

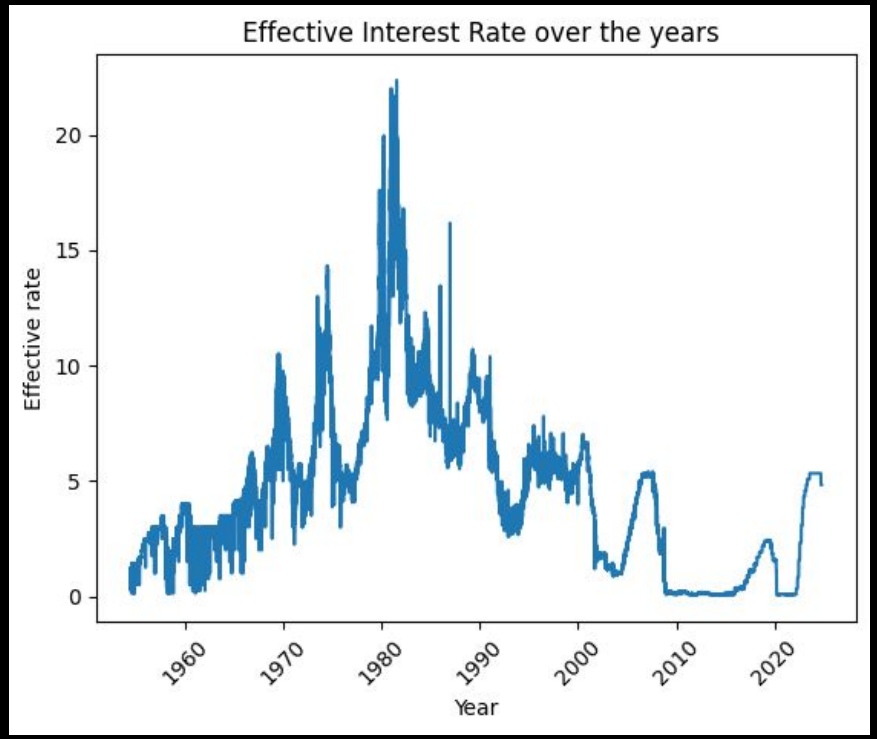
COVID-19 Pandemic Effects (2020–2021):
The onset of the pandemic disrupted global supply chains, leading to shortages of goods and spikes in production costs.

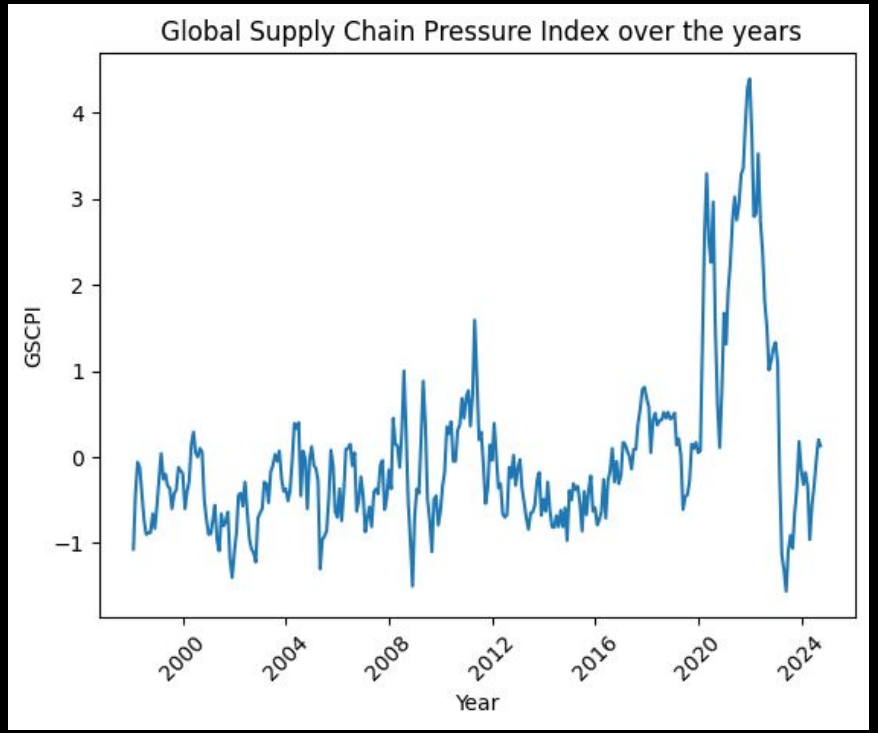
Post-Pandemic Supply Chain Disruptions (2021-2022)
The conflict in Ukraine in 2022 caused energy and food prices to spike dramatically, as Russia and Ukraine are major exporters of natural gas, wheat, and fertilizers.



Exploratory Analysis

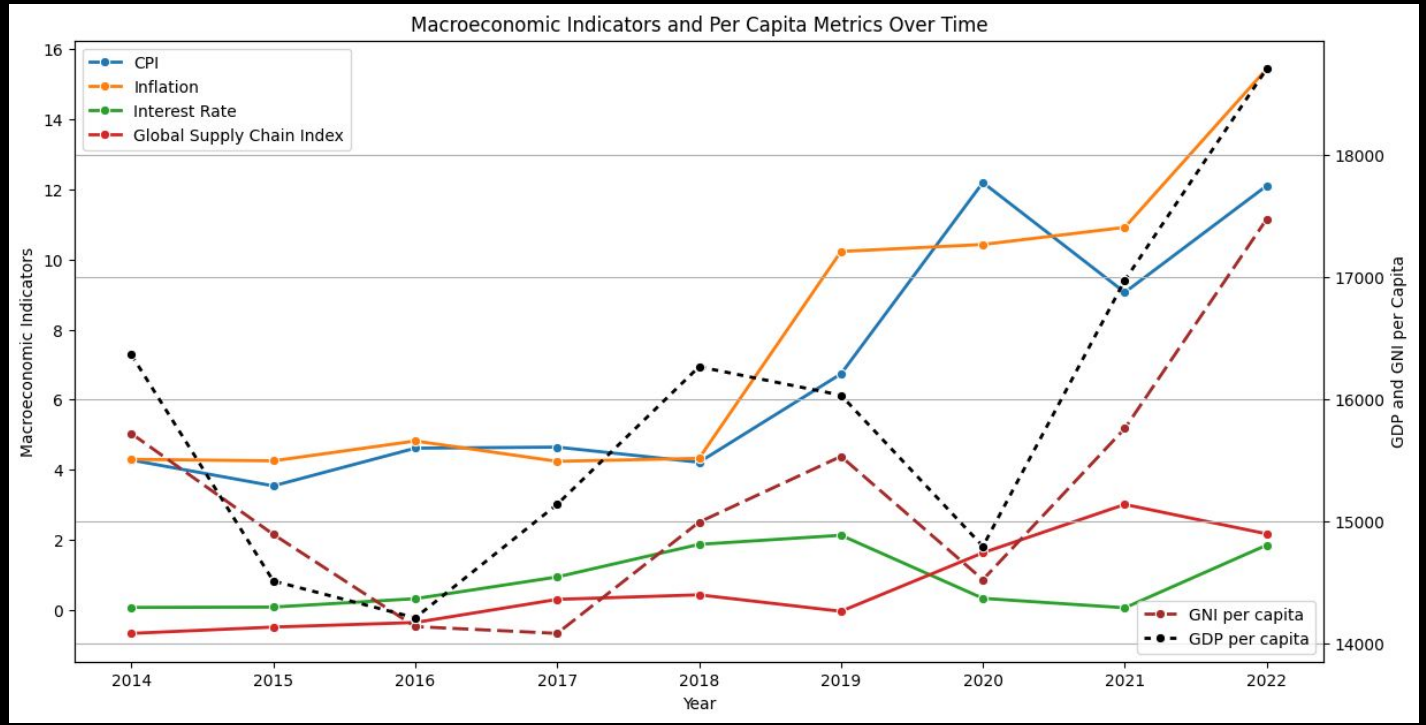
Global Interest Rates, and Global Supply Chain Pressure Index



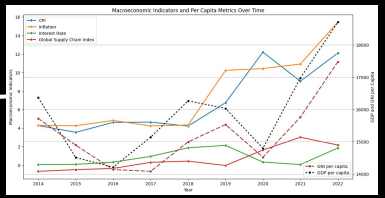


Findings

- **Globally -- CPI, Inflation, Supply Chain Pressure Index saw continued increases.**
- **Interest Rates increased post pandemic era.**
- **GDP per capita and GNI per capita decreased in 2016 and 2020 and is now at a high.**



Findings



Statistics:

Globally, GSPCI, CPI, Inflation, had the widest distribution among all the countries

GDP, GNI and interest rates had much smaller spreads relative to their means globally.

Descriptive Statistics:

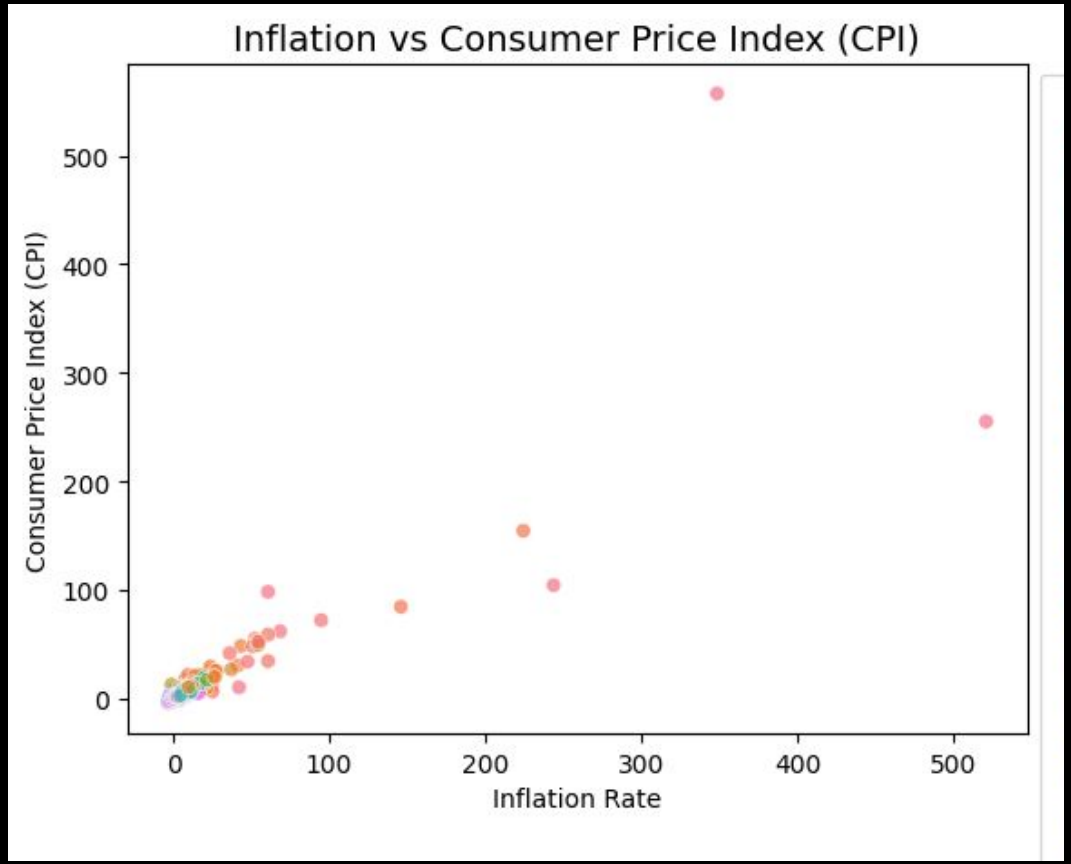
	Year	CPI	Inflation_Rate	GDP per Capita	\
count	1298.000000	1298.000000	1298.000000	1298.000000	
mean	2017.955316	5.257935	5.831587	15852.200023	
std	2.569828	19.033732	21.179237	21337.949008	
min	2014.000000	-3.750000	-5.900000	216.830000	
25%	2016.000000	0.990000	1.000000	2404.810000	
50%	2018.000000	2.720000	2.900000	6228.460000	
75%	2020.000000	5.585000	6.200000	18776.107500	
max	2022.000000	557.200000	521.100000	133590.150000	

	GNI per capita	Interest_Rate	Supply_Chain_Pressure_Index
count	1298.000000	1298.000000	1298.000000
mean	15360.801233	0.846695	0.643012
std	19944.375338	0.820410	1.220573
min	220.000000	0.060000	-0.670000
25%	2442.500000	0.080000	-0.360000
50%	6100.000000	0.330000	0.300000
75%	18287.500000	1.850000	1.630000
max	105070.000000	2.130000	3.010000

Findings

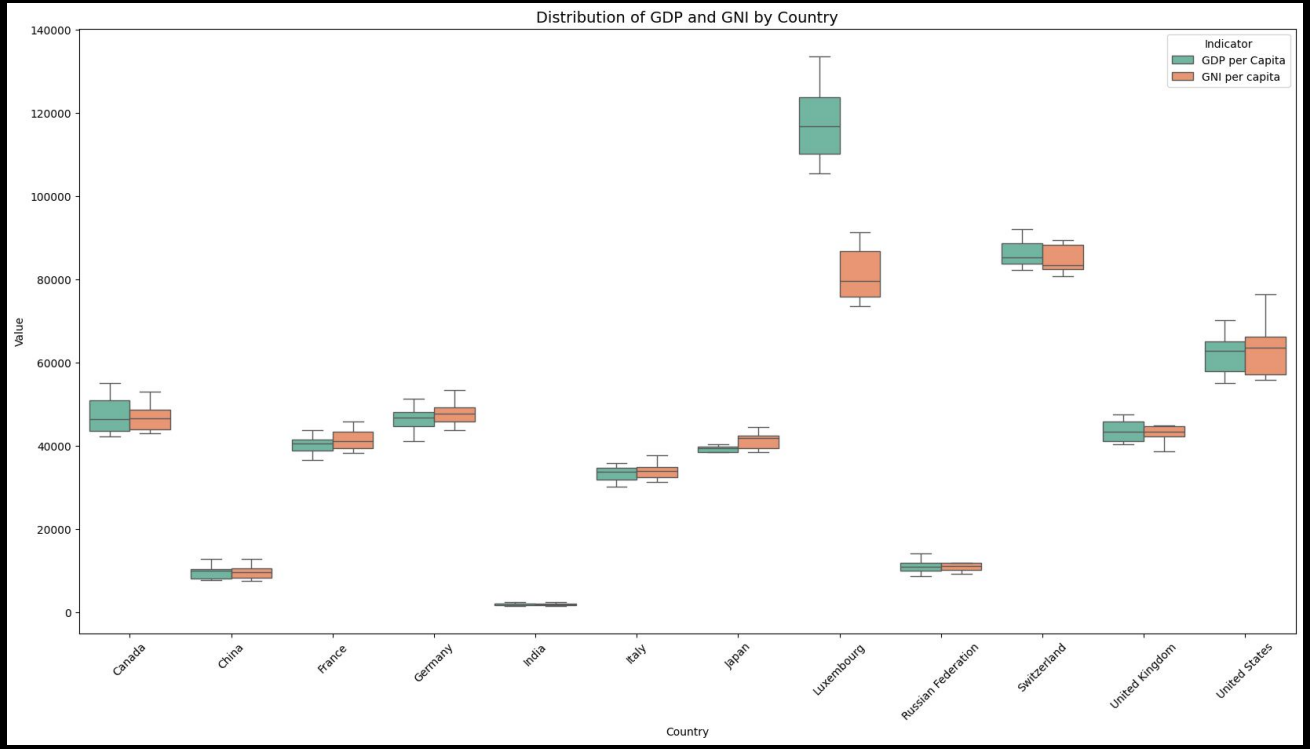
Globally, CPI and Inflation Rate have a moderate and positive correlation.

The outlier countries were Zimbabwe, Venezuela, Argentine, Surinam, Lebanon where the CPI vs Inflation rate was very high.



Findings

- **Luxembourg has the highest GDP per capita.**
- **There is a significant diff in its GDP vs GNI per capita for Luxembuorg and Japan.**
- **Switzerland has higher values than USA.**



Findings

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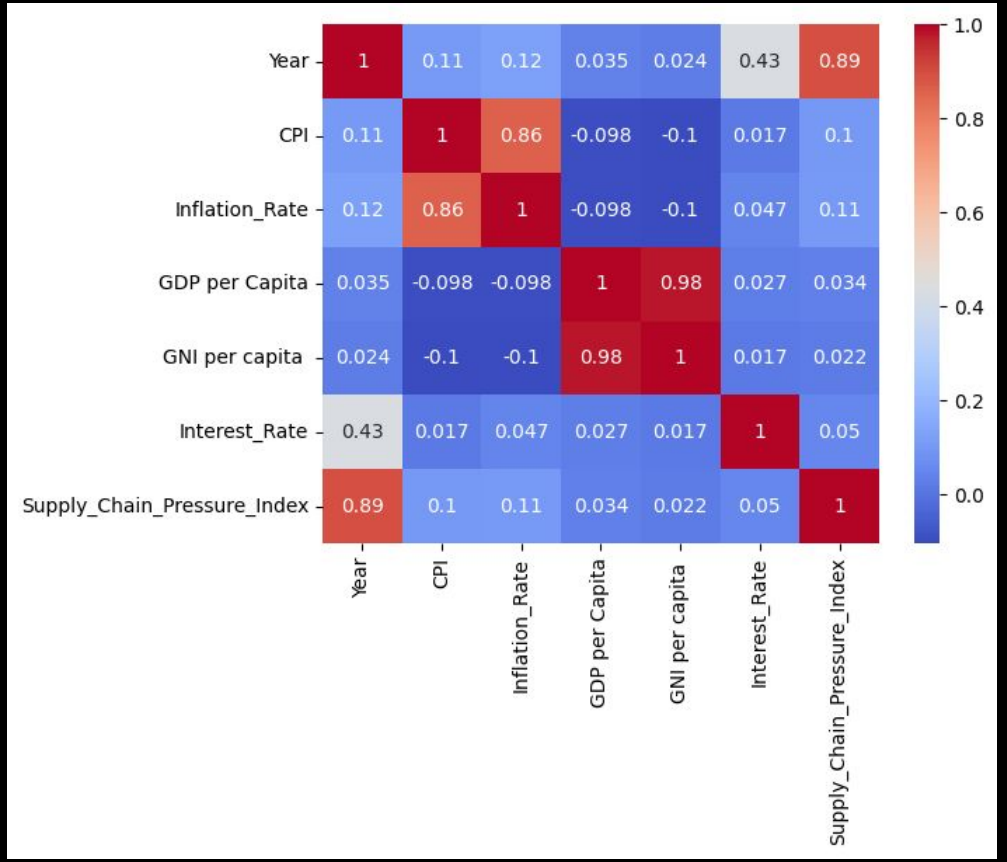
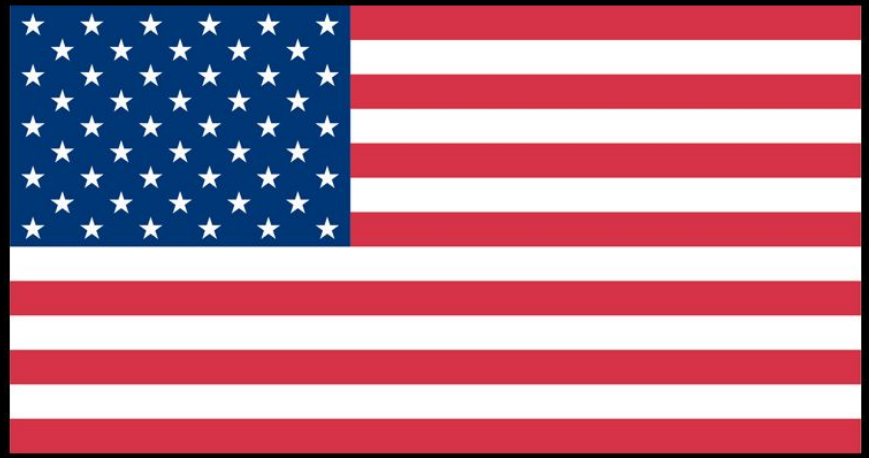
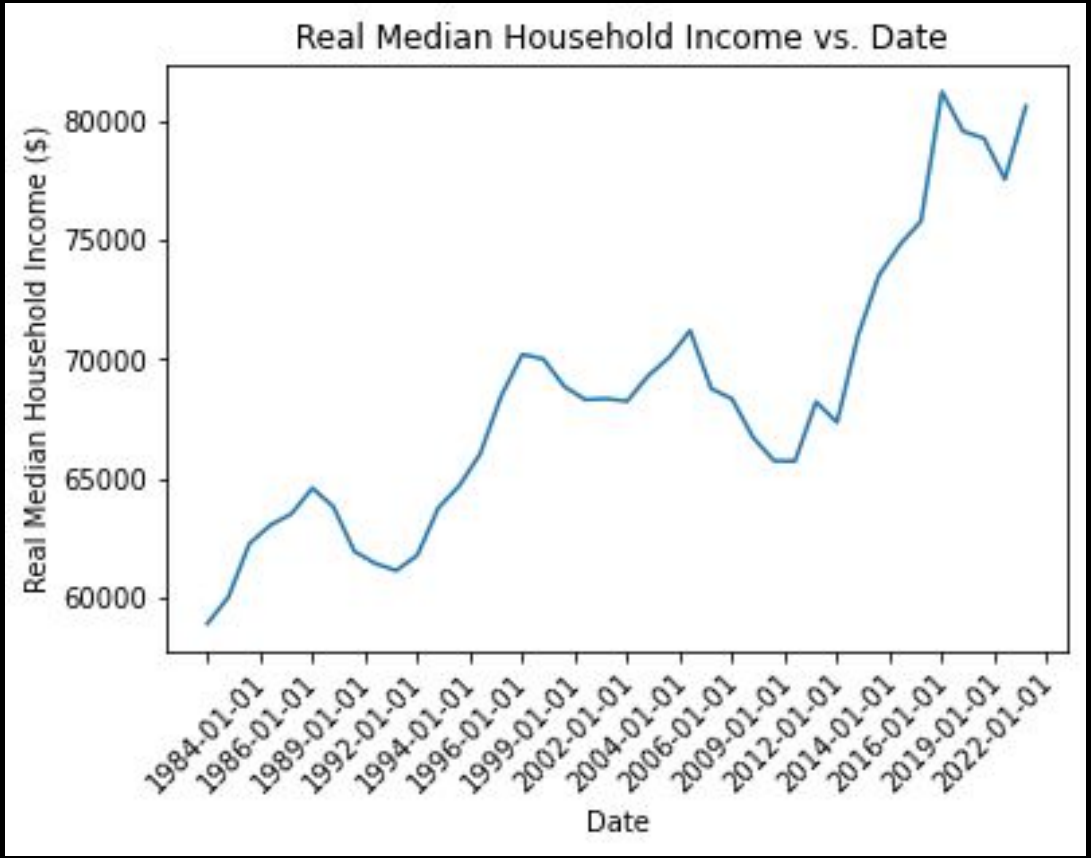


US Impact Analysis



Exploratory Analysis

US real median household income (inflation adjusted) shows that when taking inflation into account people are earning the most in the 2010s and 2020s. They were significant dips during the 80s, housing crisis, and during Covid.

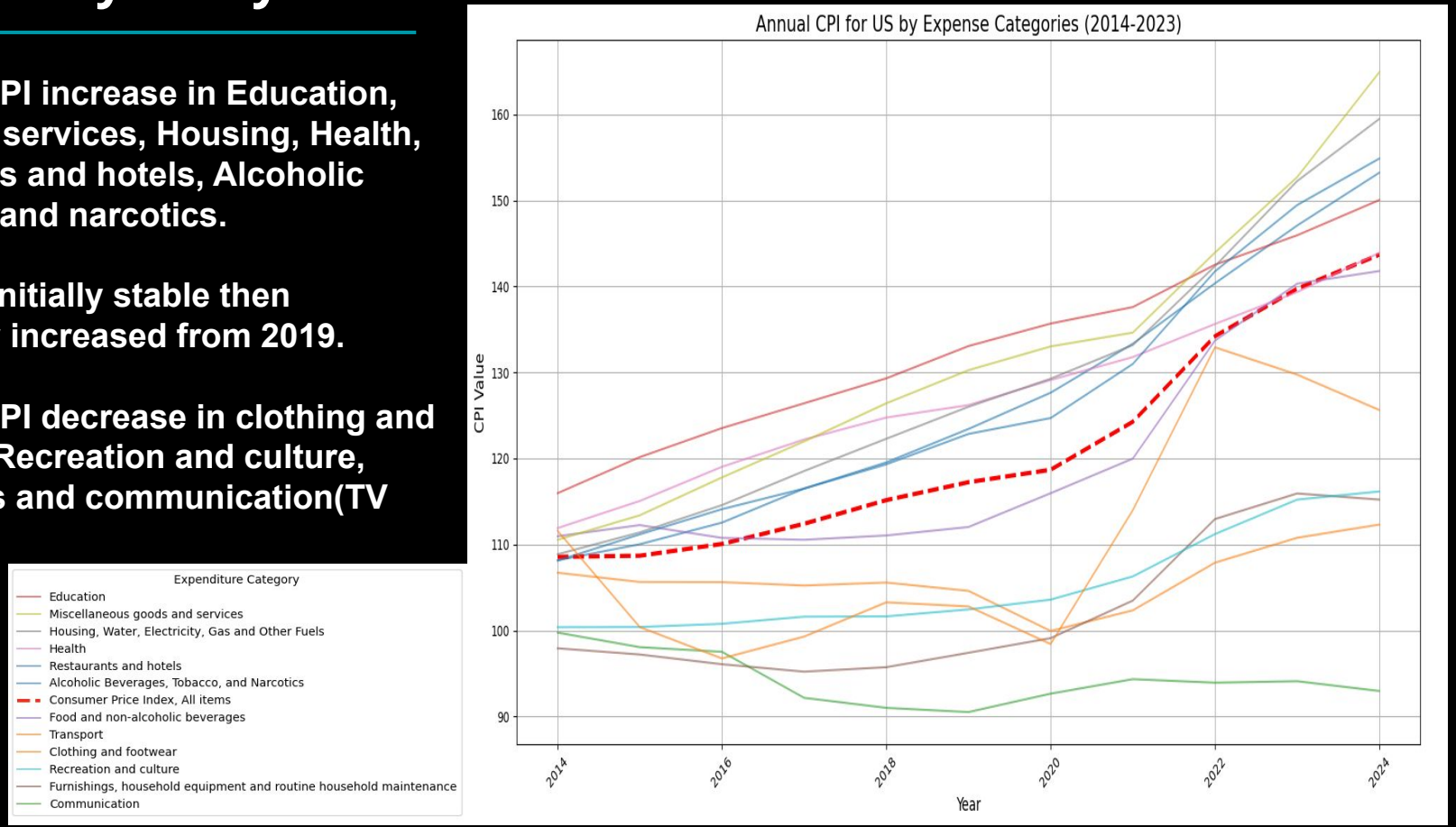


Exploratory Analysis

USA saw CPI increase in Education, goods and services, Housing, Health, Restaurants and hotels, Alcoholic beverages and narcotics.

Food was initially stable then continually increased from 2019.

USA saw CPI decrease in clothing and footwear , Recreation and culture, furnishings and communication(TV etc)



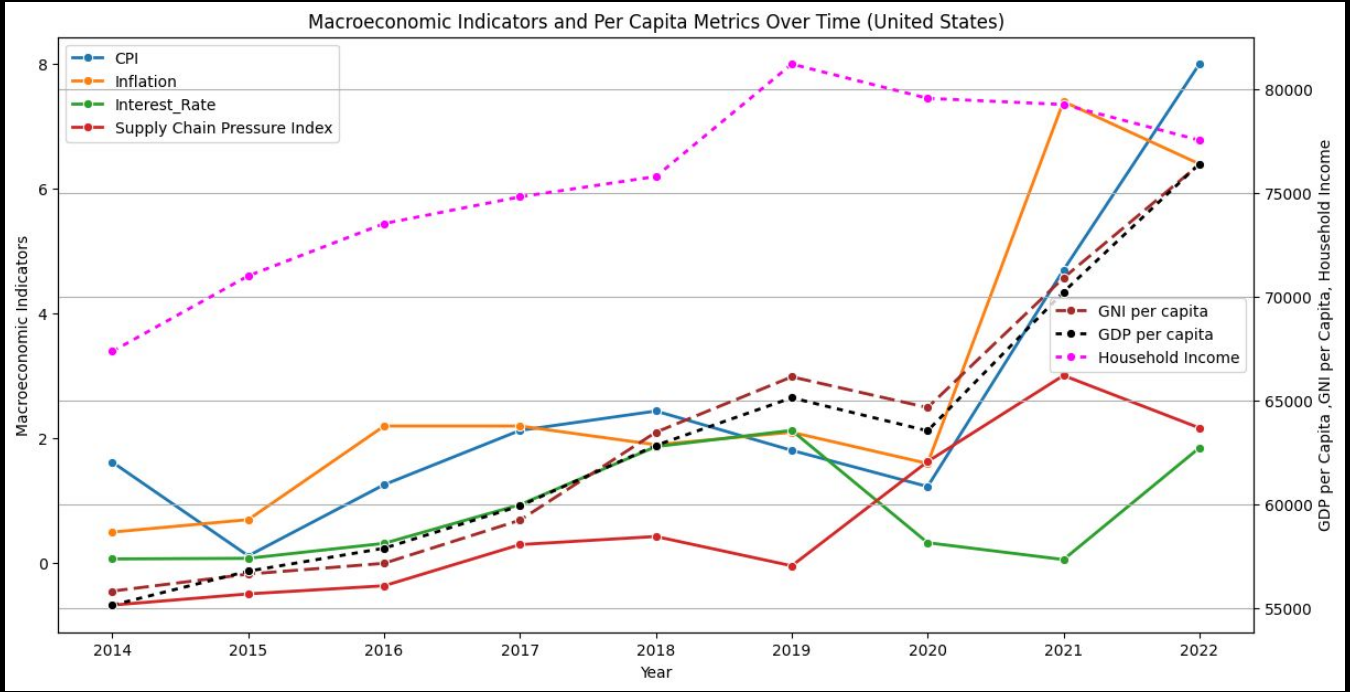
Findings

For USA, CPI , Inflation, Supply Chain Pressure Index continued to increase.

Inflation Rate was highest in 2021.

GDP per capita and GNI per capita increased over the years, reduced in 2020 and is on the rise after it.

Household Income peaked in 2019.



Findings

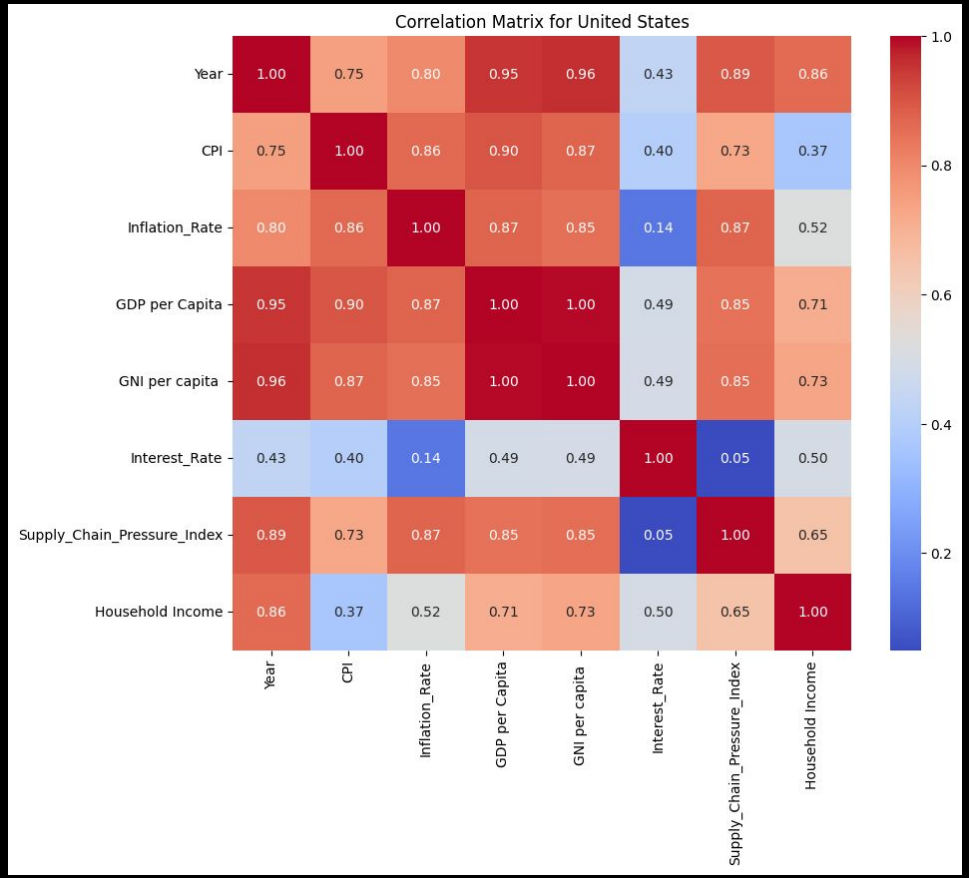
Several metrics were correlated with CPI: inflation rate, GDP and GNI per capita, Global supply chain pressure index.

The US household income was correlated with GSCPI, GNI and GDP. Inflation rate was weakly correlated and interest rate were more weakly correlated

	Year	CPI	Inflation_Rate	\
Year	1.000000	0.746399	0.796108	
CPI	0.746399	1.000000	0.864810	
Inflation_Rate	0.796108	0.864810	1.000000	
GDP per Capita	0.948938	0.898013	0.870635	
GNI per capita	0.956565	0.873074	0.847906	
Interest_Rate	0.433813	0.399783	0.144956	
Supply_Chain_Pressure_Index	0.894472	0.728456	0.872337	

	GDP per Capita	GNI per capita	Interest_Rate	\
Year	0.948938	0.956565	0.433813	
CPI	0.898013	0.873074	0.399783	
Inflation_Rate	0.870635	0.847906	0.144956	
GDP per Capita	1.000000	0.995265	0.490857	
GNI per capita	0.995265	1.000000	0.492250	
Interest_Rate	0.490857	0.492250	1.000000	
Supply_Chain_Pressure_Index	0.847350	0.852701	0.050434	

	Supply_Chain_Pressure_Index
Year	0.894472
CPI	0.728456
Inflation_Rate	0.872337
GDP per Capita	0.847350
GNI per capita	0.852701
Interest_Rate	0.050434
Supply_Chain_Pressure_Index	1.000000



Conclusions

The correlations between CPI (Consumer Price Index), inflation, interest rates, the Global Supply Chain Pressure Index (GSCPI), GDP per capita, GNI per capita, and household income in the United States over the last decade reveals the following general patterns:

- **CPI and Inflation:** These two indicators are highly correlated, as CPI is a measure of inflation based on changes in consumer prices. The annual correlation is typically strong, reflecting direct relationships between price levels and inflation trends.
- **Interest Rates and Inflation:** Interest rates tend to have an inverse relationship with inflation. Higher inflation often leads to higher interest rates as the Federal Reserve raises rates to control inflation. Recent data shows this relationship is evident over the last decade.
- **GSCPI (Supply Chain Pressure Index):** The GSCPI reflects disruptions in supply chains and has been positively associated with inflation spikes, particularly during periods like the COVID-19 pandemic. High supply chain pressures exacerbate inflationary trends.
- **GDP per Capita and GNI per Capita:** These two measures are tightly correlated as they both track economic productivity and income. Over time, both have shown gradual increases, but inflation and interest rate changes have affected their real growth.
- **Household Income:** Household income is generally higher with GDP and GNI growth. it sums up the incomes of all households and divides by the number of households.

Project Source Code

Google Collab Code
https://colab.research.google.com/drive/1qnd8BoykFZvhqvYNuoUfDRnnuxWsssHF#scrollTo=aTj2C5s0Ux6y

Thank You!