

Analysis Of Currency Exchange Rates And Most Influencing Factors

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Abstract

One of the key factors in determining a country's relative level of economic health is its currency exchange rate. Every free market economy in the world depends on trade, which is significantly influenced by exchange rates. While there are many direct and indirect factors which affect currency exchange rates, the inflation rate of a country and gross domestic product are the most prominent ones. The aim of this project is analyzing the relationship between exchange rates, GDP and inflation rates and checking if we can forecast the economic crisis using effective visualizations.

Introduction

The global economy of any nation is based on trade, which is greatly influenced by exchange rates. There are many confounding factors that affect the exchange rates, and many of these factors have to do with how the two nations' trading relations. Some of the main factors affecting the exchange rate between two countries include the purchase power parity of the country, the inflation rate of the country and gross domestic product value of the country.

Changes in interest rates have an effect on inflation and currency values, and central banks have control over both exchange rates and inflation. An economy with higher interest rates provides lenders with a larger return compared to other nations. Higher interest rates draw in foreign investment and lead to an increase in the currency rate. But if the country also has a high inflation rate, then it nullifies the high interest rates.

Gross Domestic Product (GDP) also plays an important role in bringing foreign investments in the country. A positive and stable GDP indicates that the country's people have a high standard of living and less inflation rate. If the GDP of the country is high and is continuously increasing during the past few years, it is an indication that the country has a stable economy and it would be a safe investment in that country.

Background

The International Monetary Fund said in October that the world economy was headed for “stormy waters”. It warned of a harsh worldwide recession if policymakers mishandled the fight against inflation. The International Monetary Fund lowered its growth outlook for 2023 and suggested that interest rate increases could spur a harsh global recession.

A global recession could mean poor performance of the global economy for several months, and higher unemployment rates. People tend to spend less during these times which in turn lower the GDP of the country and may lead to an increase in the inflation rates.

It is important to understand these economic factors because:

- It affects trade and bilateral relations.
- To analyze the supply and demand in the open market.
- It affects what a customer pays for goods and services
- It collectively affects the economic activity
- It indirectly has an effect on the Housing Market

As a new graduate student navigating through the corporate world during a global recession, this topic is of particular importance to us. We are interested to do an analysis and learn more about relationships among currency values, GDP and inflation rates of the countries.

Objective

The aim of this project is to perform an in-depth analysis of the relationships between currency exchange rates, GDP, and inflation rates.

We aim to answer the following research questions:

- Which currencies have strengthened compared to the US dollar over the past decades?
- How do major world events like recessions, global pandemics or war affect the exchange rates?
- How does the exchange rate relate to the relative economic downturn?

Answering these questions would help us in forecasting the currency exchange rate which can help businesses and policymakers make informed decisions to help minimize risks and maximize returns.

Existing Work

1. Existing Visualization for Exchange Rates

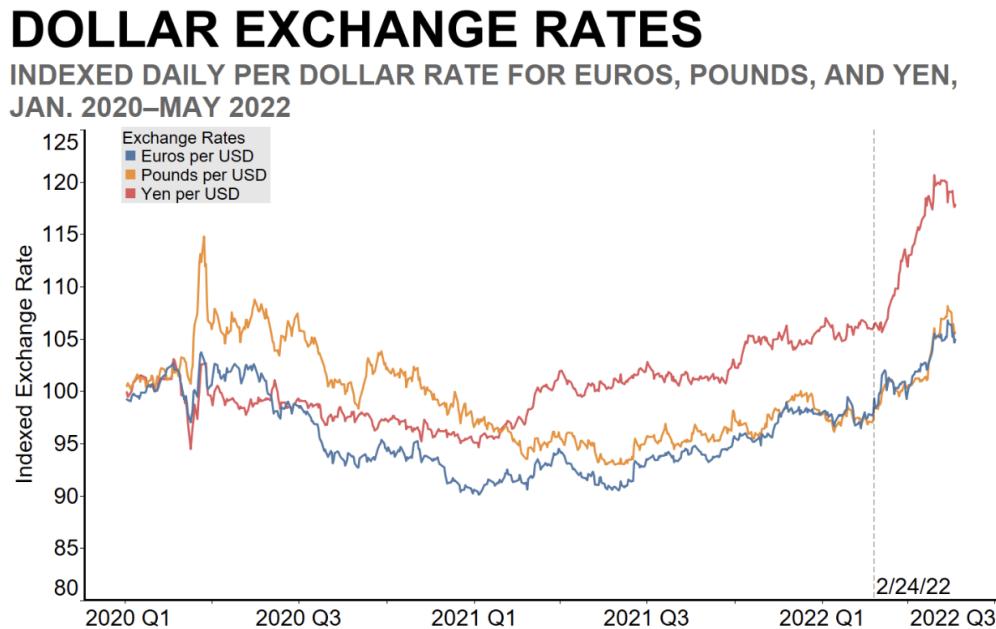


Figure 1: Dollar Exchange Rates

Figure 1 shows us the exchange rates of Euros, Pounds and Yen with respect to the USD. It compares the currency exchange rates during quarters 202 Q1 to 2022 Q3.

As we can clearly observe from this graph, all the currencies dropped drastically between 2020 Q3 to 2021 Q3. This drop is mostly due to the pandemic, where the trading between almost all the countries was limited and was also done in a very safe and secure way. But after the 2021 Q3, we can see that Euros and Pounds strengthened their exchange rates with respect to USD, whereas Yen's rate kept on increasing.

The main problems with this graph are as follows:

- a. The range of the x axis scale is very small. If the scale was more elaborate, we could have a better understanding about the pre-Covid exchange rates. This would help us understand how Yen was before and after covid. Were the values still high for exchange rates or were they lower.
- b. Secondly, for this graph, we don't know the exact value of the exchange rates at any particular moment in time. We can surely make an approximation with the y axis scale, but it might give us wrong values.
- c. Next, if we had more countries to compare the exchange rates with respect to USD, it would give us a better understanding of the variation in exchange rates during various periods of time.

2. Existing Visualization for Gross Domestic Products

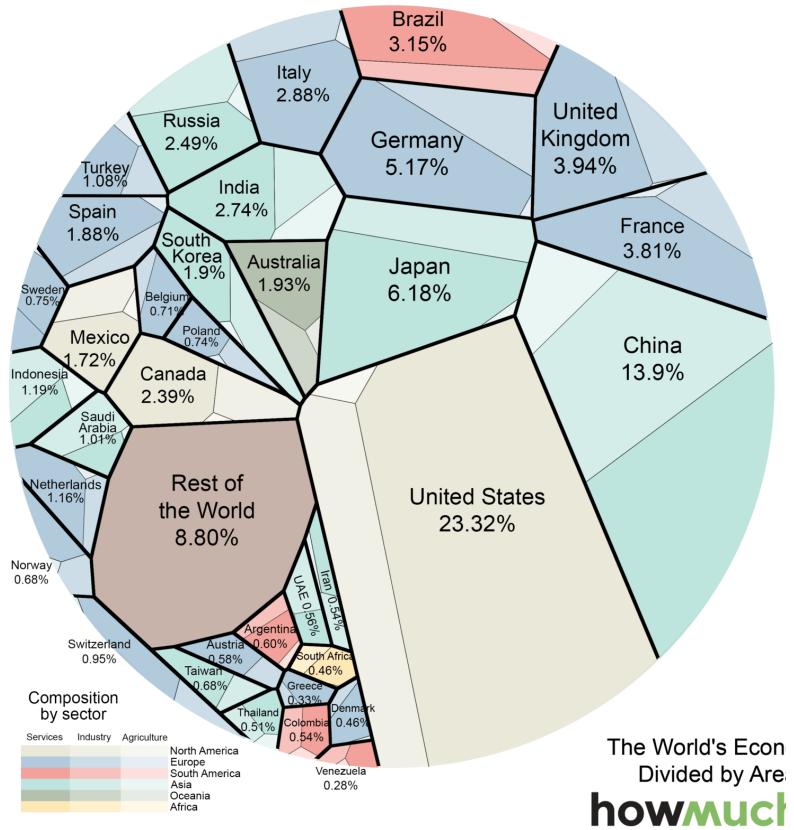


Figure 2: GDP share of each country using the area

Figure 2 is for a GDP visualization of all the countries in the world. Though this graph seems to represent the information in a particularly interactive way, there are some problems associated with it, which are as follows:

- The colors and hues to represent the countries and associated continents are not very colourblind friendly. The colourblind person can get confused with the colors and don't use the graph properly.
- Secondly, they use the area as a means to express the percentage GDP contribution of countries towards world GDP. They have represented this number by indicating the percentages of each country on the map. However, if we closely observe countries like Australia, South Korea and Spain, we can see that though their %GDP seems to be close enough, their areas don't necessarily depict the same thing. Australia and Spain seem to have more area as compared to South Korea.
- Thus, though representing the percentage of GDP on a graph is useful, the choice to represent the GDP by area is quite deceptive.

3. Existing Visualization for Gross Domestic Products

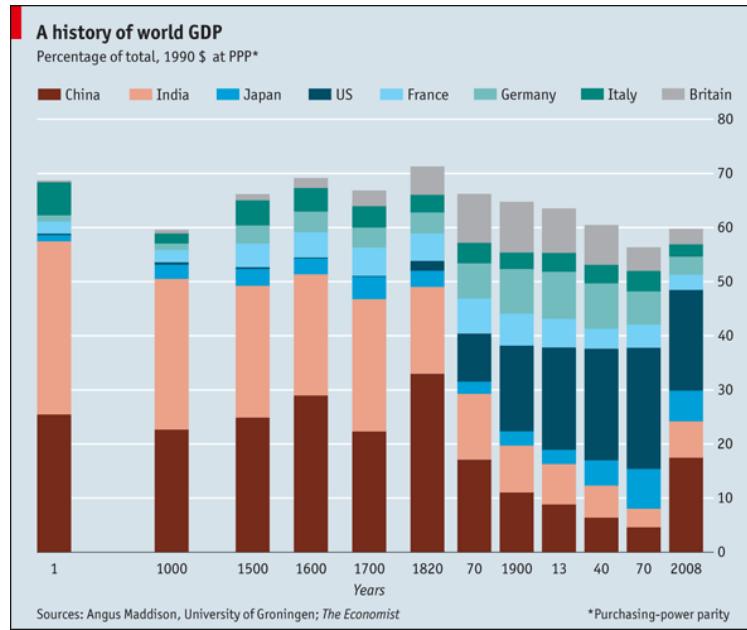


Figure 3 : GDP% of countries using bars during different eras

Figure 3 shows the percentage GDP of the world's 8 countries from 1AD to 2008AD. The following are the pros and cons of the above GDP graph:

- This graph has some pros like it represents the %GDP using bars which is essentially length. It is also a well known fact that lengths are visually more helpful to represent the correct values and give a uniform perspective of the range.
- However, the time period used for the graph is not correct. It is so because we are not sure if all the countries represented in the graph actually existed at that time or not. The question also rises about how the GDP of any country was calculated at that time.
- Though the use of bars helps us to understand how much the countries contributed to the world economy, still we cannot gauge the actual values of each country.
- The hues and color contrast used in the graph will make it difficult for colourblind people to understand them. A better color scheme could be used for representing different countries.

4. Existing Visualization For Inflation

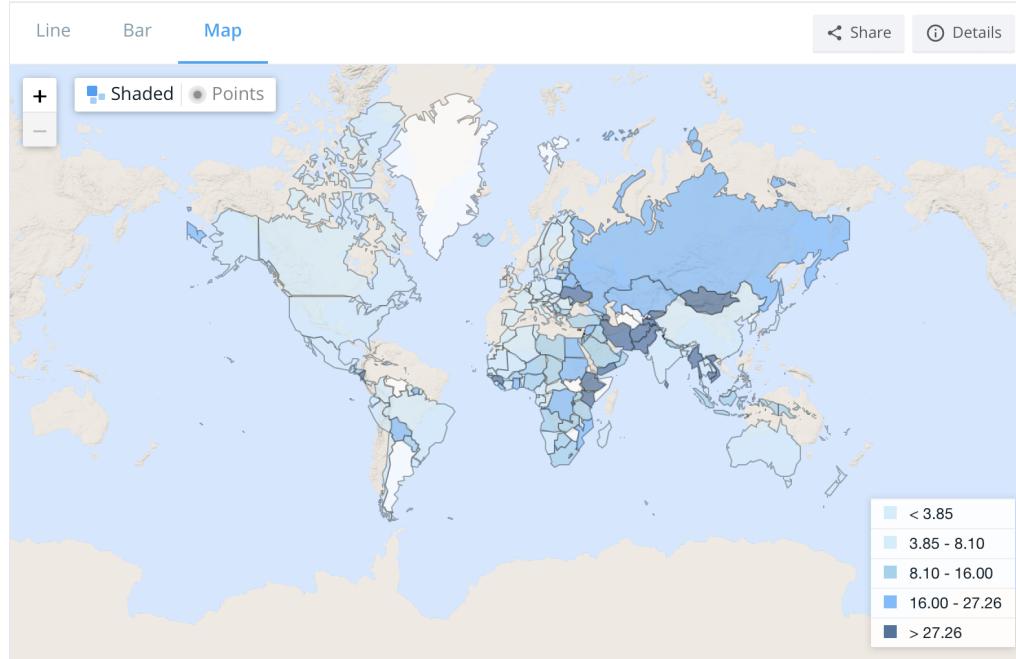


Figure 4: Existing Visualization For Inflation Rates

Figure 4 represents the inflation rate for all the countries all over the world. This visualization is hosted on the World Bank website. This is an interactive slider graph which shows the inflation rate for each year from the 1960s to 2021. While representing the inflation rates of all countries using Mercator map seems to be a wise option, there are a few problems with the map:

- a. The color scheme that they have used to represent the inflation rates is Blue. And the water bodies on the map are also represented using the Blue color. Thus as we change the scale for viewing the inflation rate for different years, the color of the water bodies changes along with the inflation rates of the countries. So, even though the inflation rate of all the countries might not have changed from one year to the next, the change in the water bodies gives a perception of it.
- a. Secondly, the scale that they are using for inflation rates is discrete instead of being continuous. Thus, countries which might be on the borders of any of the classes, would still be categorized with countries which are in the middle of the class. This represents a flawed graph.

Methodology

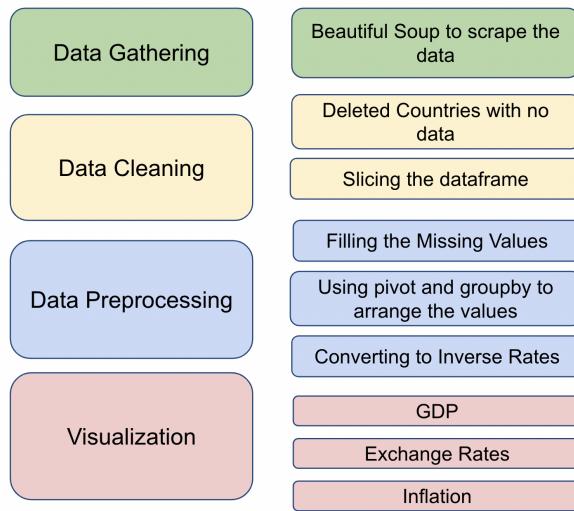


Figure 5.1: Architecture diagram of Methodology

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1 df4 = df4.fillna(method='ffill').fillna(method='bfill')
2 df4.isna().sum()

Date          0
U.S. dollar(USD) 0
U.K. pound(GBP) 0
Japanese yen(JPY) 0
Brazilian real(BRL) 0
Indian rupee(INR) 0
Canadian dollar(CAD) 0
Chinese yuan(CNY) 0
Euro(EUR) 0
dtype: int64

1      #converting these to inverse rates
2      df4['USD']=1/df4['U.S. dollar(USD)']
3      df4['GBP']=1/df4['U.K. pound(GBP)']
4      df4['JPY']=1/df4['Japanese yen(JPY)']
5      df4['BRL']=1/df4['Brazilian real(BRL)']
6      df4['INR']=1/df4['Indian rupee(INR)']
7      df4['CAD']=1/df4['Canadian dollar(CAD)']
8      df4['CNY']=1/df4['Chinese yuan(CNY)']
9      df4['EUR']=1/df4['Euro(EUR)']

10
  
```

Figure 5.2 Explains the entire architecture of the methodology followed.

1) Data Gathering

- The GDP data was scraped from Wikipedia using BeautifulSoup. The dataset consists of the GDP data of the top 12 countries from 1995 to 2020. We use the same top 12 countries throughout our approach. The countries are the United States, China, India, Japan, Germany, France, United Kingdom, Italy, Brazil, Spain, South Korea, Canada.
- The Currency Exchange Rates for the top 12 countries was downloaded from the IMF's Currency Exchange Rate Tool. With the help of this tool, we can download the exchange rates of any country for any duration of time period in a csv file. We then merged the files together to create one big dataset.
- For the inflation rates dataset, we downloaded the dataset from the World Bank site. They had data starting from the 1960s to 2021. However, we are using the dataset only from 1995 to 2020.

2) Data Cleaning

- a) For the exchange rate data, we sliced the dataframe to include the top 12 countries or the top 8 currencies.
- b) For the inflation data we deleted countries with no reported values like Angola, Greenland.

3) Data Preprocessing

- a) For the exchange rate data, we converted the SDRs into inverse rates and converted them into currency units per USD.
- b) For the inflation data we filled in the missing values using forward fill and backward fill since the data was time series and then pivoted the dataframe so that we could plot the data country wise and then year wise.

4) Visualization

- a) Exchange rate analysis
- b) Inflation analysis
- c) GDP analysis
- d) Inflation vs Exchange Rate Analysis

Results

1) Exchange Rate Analysis (Visualization of Currency Units per USD)



Figure 6: Interactive Visualization Of Exchange Rates (Linear Scale)

Currency Values Against USD For Major Economies (2000-2022)

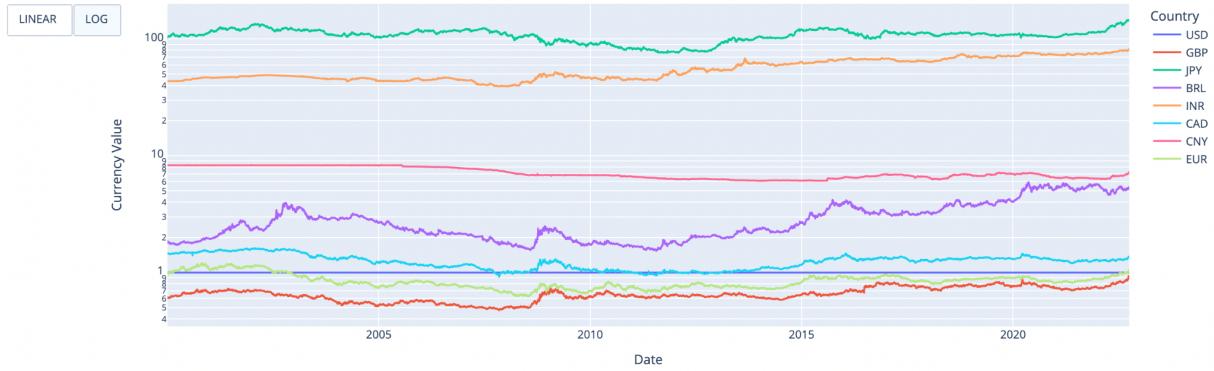


Figure 7: Interactive Visualization Of Exchange Rates (Log Scale)

Figure 6 and 7 show the visualization of the currency exchange rate against the USD for all the major economies in the world. The time scale is from 2000 to 2021. The visualization provides both linear and log scale.

- The linear scale is used to check the precise values.
- The log scale is used to capture the trends effectively
- The labels are used to capture and compare the values of all the 8 currencies across all time-periods.
- This could be a valuable tool for those interested in the foreign exchange (FX) currencies market
- Traders could use historical exchange data as part of their quantitative analysis to identify trading opportunities.

Case Study: Japan's Serious Recession in 2008



Figure 8: Case Study Of Japan's Economy

Figure 8 shows us the value of Yen with respect to USD in December of 2008. If we closely observe we can see that in the previous months there was a sharp drop in the currency units (The currency appreciated in comparison to the USD) i.e with less units of Yen we could have bought more units of dollar. In late 2008, Japan's currency sharply appreciated in a matter of 4-5 months. This is a strong indicator of an impending recession. Through this analysis, we can understand how long it takes for an economy to go back to normal after a recession and use it in the future to better prepare for the outcomes.

2) Inflation Map Slider (Visualization Of Inflation Rates from 1995-2021)

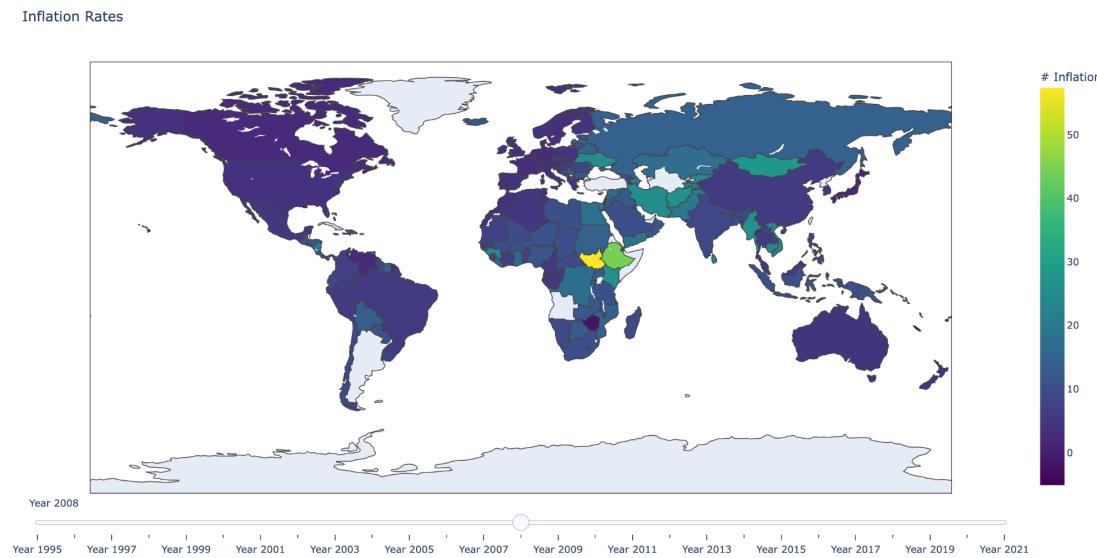


Figure 9: Interactive Map Slider of Inflation Rates

Figure 9 is an interactive map slider that shows us the inflation rates across all the countries in the world from 1995 to 2021.

- A choropleth map is useful in this case because it is useful in providing analysis based on countries. This could be easier for a comparison of based on socio demographic status like the richer countries and the poorer countries
- Since inflation is just based on country not on population or density a cartogram is less useful for this kind of analysis.
- A Perceptually Uniform Colour Maps to denote uniform changes in the data.

Case Study: HyperInflation in Venezuela

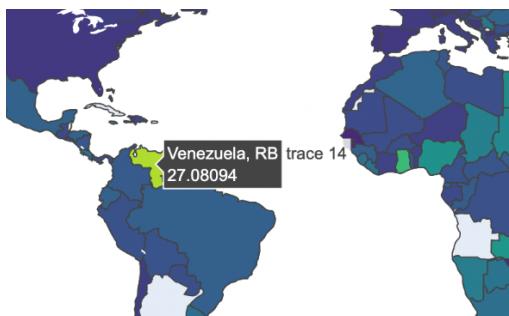


Fig 10: Inflation Rate 2009



Fig 11: Inflation Rate 2017



Fig 12: Inflation Rate 2019



Fig 13: Inflation Rate 2021

Through our Figures 10,11,12 and 13 we observe and infer that the inflation in Venezuela keeps rising steeply and it is more than anywhere in the world. The hyperinflation and the currency instability is at an all time high since 2016. Our interactive map could be good for case studies where, with the help of the slider we can very easily and quickly compare data for different time periods.

3) GDP Analysis

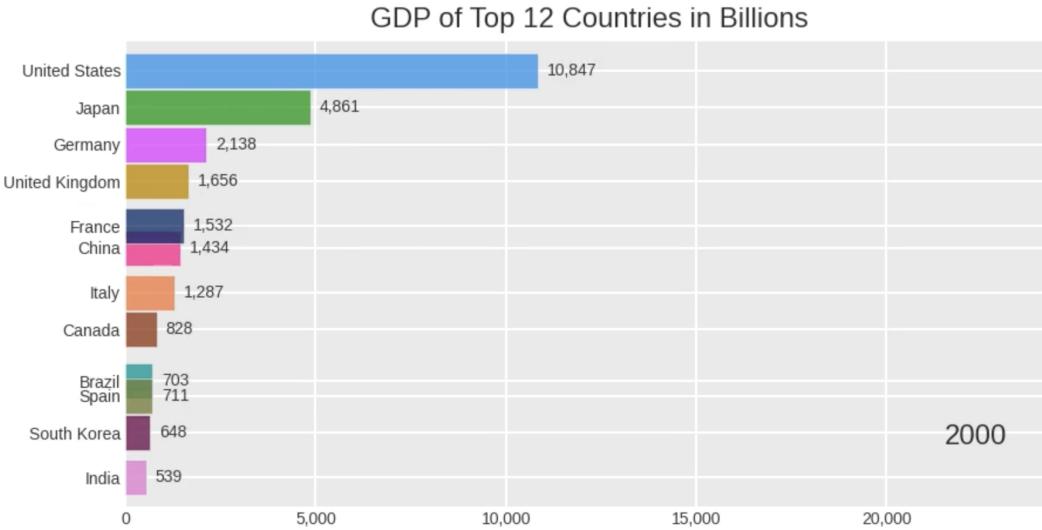


Figure 14: GDP of Top 12 Countries

Figure 14 shows us the GDP runner of the top 12 highest GDP contributing countries in the world. This graph shows the GDP from 1995 to 2020 in an interval of 5 years. The graph also shows the total GDP of the country in billions of dollars in USD values.

The unique quality of this graph is that, though it is a 2-D graph, time being the third axis helps us get an understanding of the trend that developed in the world over the given time period. It also shows the rate of change of GDP for different countries.

The bars, colors, labels, and numbers representing the GDP of each country make the graph visually perceptive and easily interpretable for everyone.

4) Exchange Rate vs Inflation Rate Analysis: INDIA

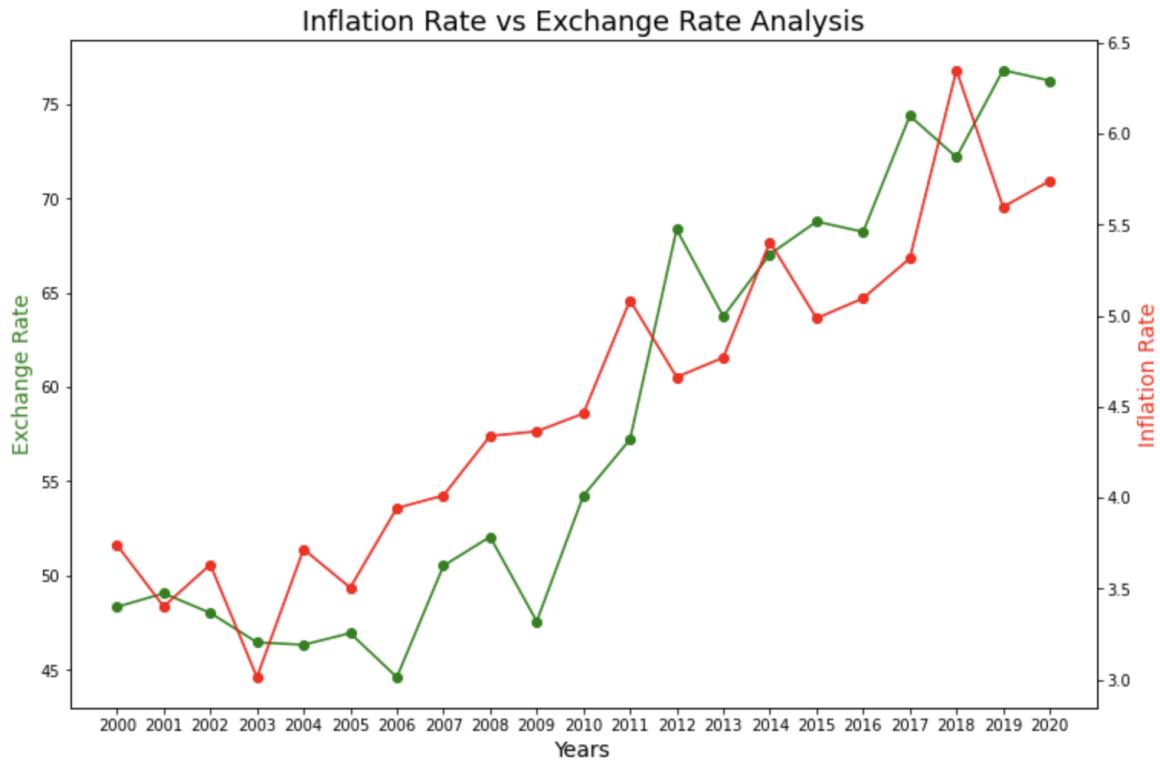


Figure 15: GDP of Top 12 Countries

Figure 15 shows us the relationship between GDP and Exchange rates. We based our analysis on India. We collected the data from 2000 to 2021. Since exchange rate data was recorded monthly, we took a 12-month average for each year to get the yearly data. Since exchange rates and inflation rates have different scales, we plotted our data on two different y axes.

Through this analysis, we can understand that the rate of inflation in a country can have a major impact on the value of the country's currency and the rates of foreign exchange it has with the currencies of other nations. This is shown by how depreciation in the exchange rates causes rise in the inflation rates. However, inflation is just one factor among many that combine to influence a country's exchange rate.

Inflation is more likely to have a significant negative effect on a currency's value and foreign exchange rate. While a very low rate of inflation does not ensure a country will have a favorable exchange rate, a very high rate of inflation is very likely to have a negative effect on the country's exchange rates with other countries.

It should also be noted that the impact of inflation on the exchange rate is theoretical. Indeed, many other factors are taken into account in determining the exchange rate.

Conclusion

Through our graphs, researchers can observe recession indicators with exchange rates and analyze the historic economic trends to predict the time the market actually takes to recover from recession.

Map visualizations along with time sliders are the best for a global analysis because they allow us to visualize information tied to geography, compare and analyze data from across locations and more importantly compare data across different time periods.

The comparative graph is good for theoretical understanding on how inflation affects the currency exchange rate and in turn the bilateral trade relationship

Discussion and Future work

While we discuss only Currency Exchange Rates, Gross Domestic Product Values and Inflation Rates of different countries of the world and try to find relationships between them, there are many other rates and values which impact the countries' economy and these rates. One of them is Interest Rates. When we have higher interest rates in the country, we attract more foreign investments into the country. The investors would get more returns on their investments. So they would invest huge amounts of money which would strengthen their exchange rates and indirectly influence the GDP of the country as well. In future, we could do an analysis of how Interest Rates and Exchange Rates are related.

Next important thing we can work on is developing a system to predict any impending market recession. If we can come up with such a system, then people around the world can prepare for such an event and be prepared for any difficulties they might face.

We can also work towards creating a model to forecast the GDP and possible inflation rates of the country. Machine learning algorithms and models can help us achieve it and make it possible for researchers, market analysts and bureaucrats to make informed decisions about the country's economy and how to manage the funds accordingly. It might help the country evade a crisis like recession.

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