Final
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1) Introduction

There has been a lot of recent public discussion about the possibility of an impending crisis in the United States. The judge of recessions, the National Bureau of Economic Research, has not, as of yet, issued a recession declaration. The diagnosis of a recession frequently relies on trends in a variety of macroeconomic indicators, including income, personal consumption, wholesale and retail sales, industrial output, and employment. Table 1 from the Federal Reserve Bank of St. Louis displays the average percentage change for each recession since 1947 for (1) the time period prior to the recession, which is defined as the fiscal quarter prior to the peak and quarter designating the peak, and (2) the first two quarters following the peak. It is feasible to (partially) identify an upcoming and present recession through comparison to these historical percentage changes in economic indicators.

Table 1. Percentage change of economic indicators across historical recessions.

Indicator	Prior to Recession	Two Subsequent Quarters
Real personal income	0.62%	-0.83%
Household employment	0.30%	-1.42%
Real personal consumption	0.48%	-2.92%
Wholesale-retail sales	0.28%	-0.95%
Industrial production	0.05%	-2.79%

Specifically, the report takes in deep dive into (in order) –

- The patterns of clustering across states are based on economic indicators and the attributes influencing the clustering.
- A time series analysis of changes in economic indicators in the U.S. from 2020 to 2022
- The projected future values of these economic indicators for the U.S. in 2023
- Suggestions on additional data and analyses would be useful to further inform the assessment of whether or not the U.S. is entering or in a recession

2) The dataset

The two datasets used in the analysis are, the first dataset (State.csv) includes economic indicator data for each state in the U.S.; data reported for each variable are the most recent values that have been publicly reported. The second dataset (Quarter.csv) includes quarterly economic indicator data for the entire U.S. from Q1 2020 to Q4 2022.

Table - Data descriptions for State.csv

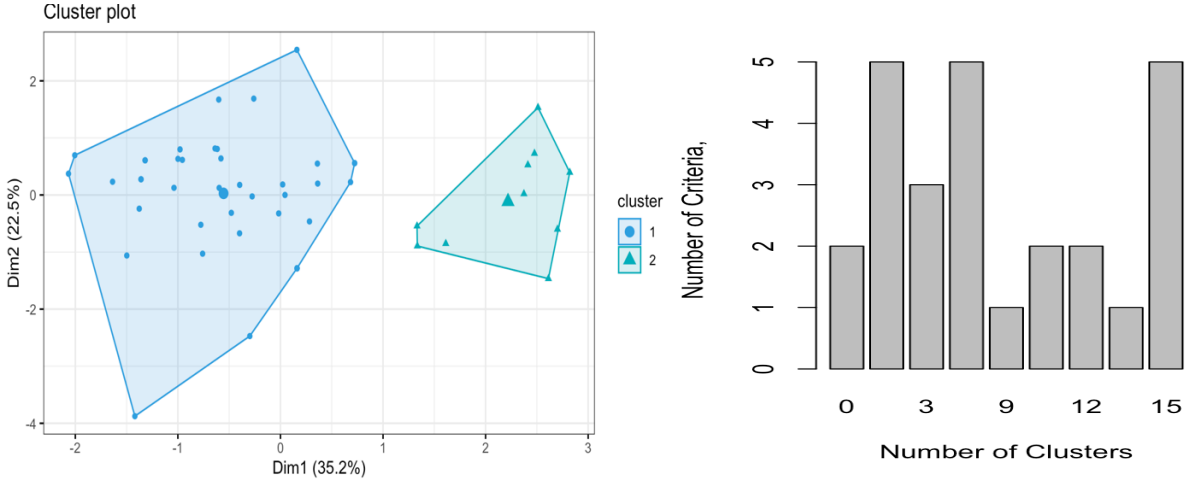
Variable Name	Variable Description
state	State name
income	Percentage change in personal income from Q2 2022 to Q3 2022
employment	Percentage change in private employment from Q1 2022 to Q2 2022
expenditures	Percentage change in real personal consumption expenditures from 2020 to 2021
gdp	Percentage change in real gross domestic product from Q2 2022 to Q3 2022

Table - Data descriptions for Quarter.csv

Variable Name	Variable Description
date	Quarter of observation (e.g., 1/1/2020 is Q1 2020)
income	Percentage change (relative to previous quarter) in real personal income excluding current transfer receipts
employment	Percentage change (relative to previous quarter) in employment (nonfarm)
expenditures	Percentage change (relative to previous quarter) in real personal consumption expenditures
manufacturing	Percentage change (relative to previous quarter) in real manufacturing and trade industries sales
production	Percentage change (relative to previous quarter) in industrial production index

3) Cluster Analysis

Using K means clustering it can be seen that the data is divided into 2 different clusters.



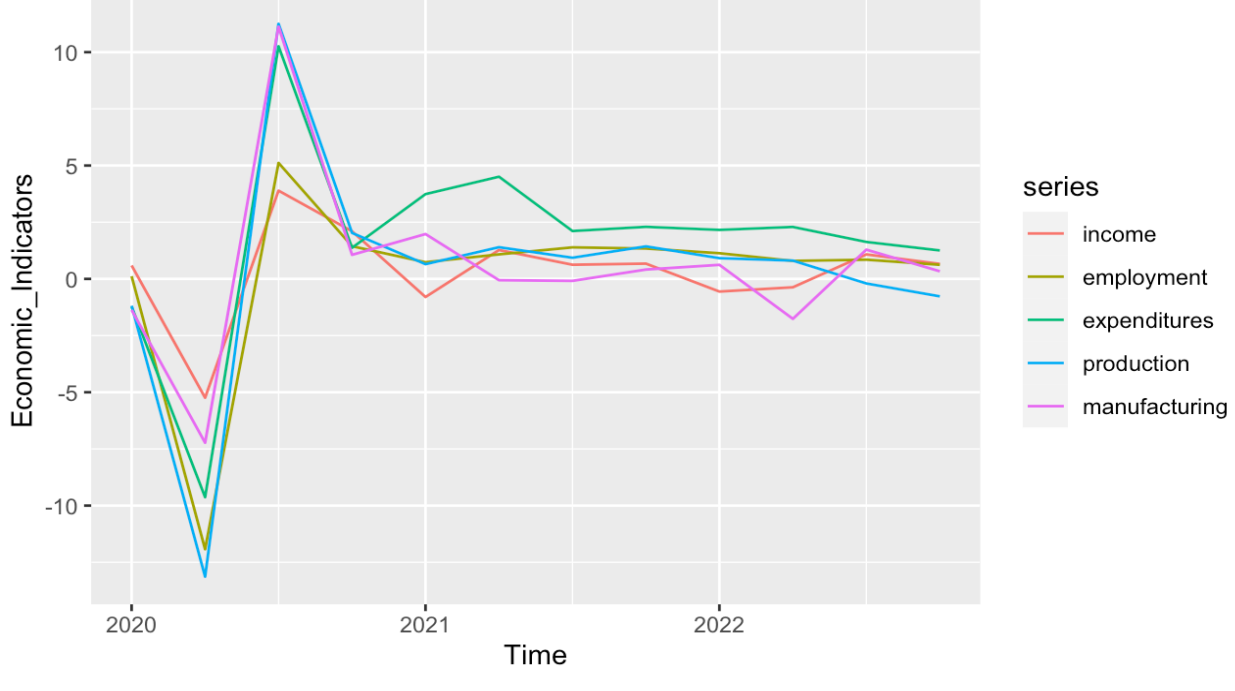
With the cluster plot around 57.7% of the variability can be explained using the first 2 dimensions.

Mean Values of economic indicators -

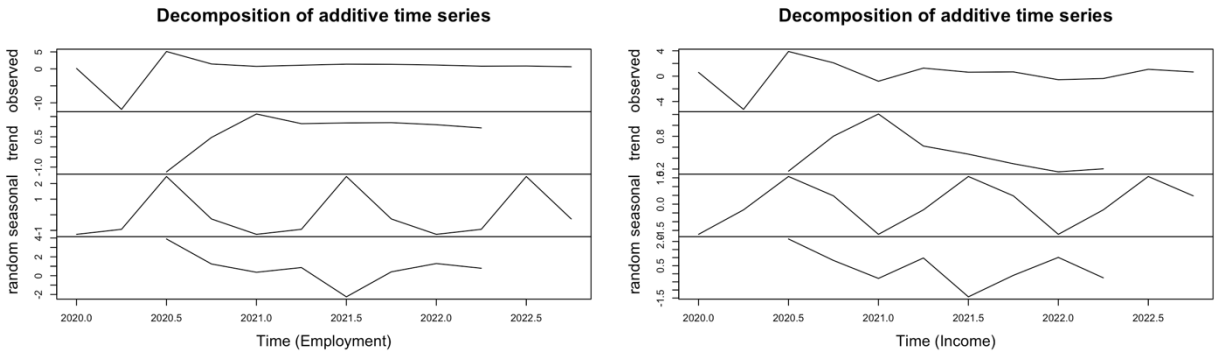
cluster <int>	employment <dbl>	wages <dbl>	gdp <dbl>	income <dbl>	expenditures <dbl>
1	-0.07%	-0.02%	-0.23%	-0.44%	-0.27%
2	0.26%	0.10%	0.93%	1.75%	1.07%

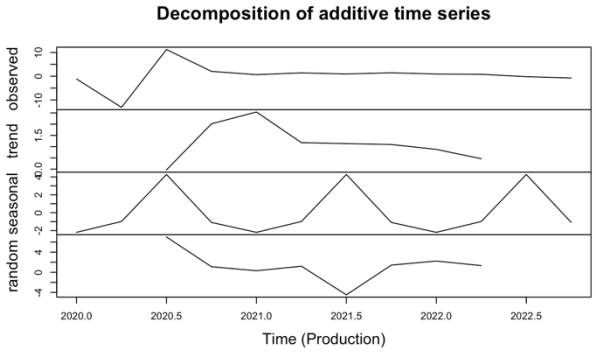
With the mean values of the economic indicators, it can be seen that cluster 1 seems to be approaching recession as their percentage values are negative. To be specific, the Percentage change in private employment from Q1 2022 to Q2 2022 is -0.065% as opposed to the historical 0.30% prior to the recession, same with the Percentage change in real gross domestic product from Q2 2022 to Q3 2022 is -0.23 for cluster 1 and Percentage change in personal income from Q2 2022 to Q3 2022 is -0.43 as opposed to historical 0.62% before the recession. Whereas for cluster 2, all the mean value of all the economic indicators seems to be positive meaning there seem to be no signs of recession for cluster 2.

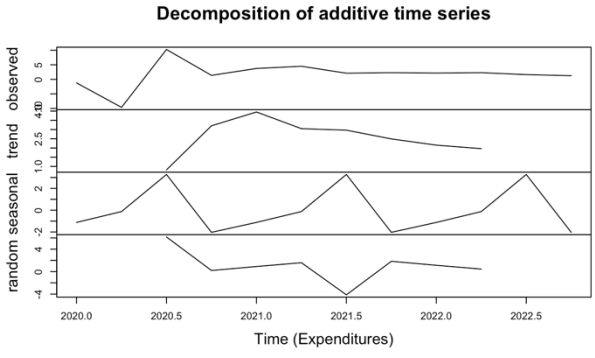
4) Time Series Analysis

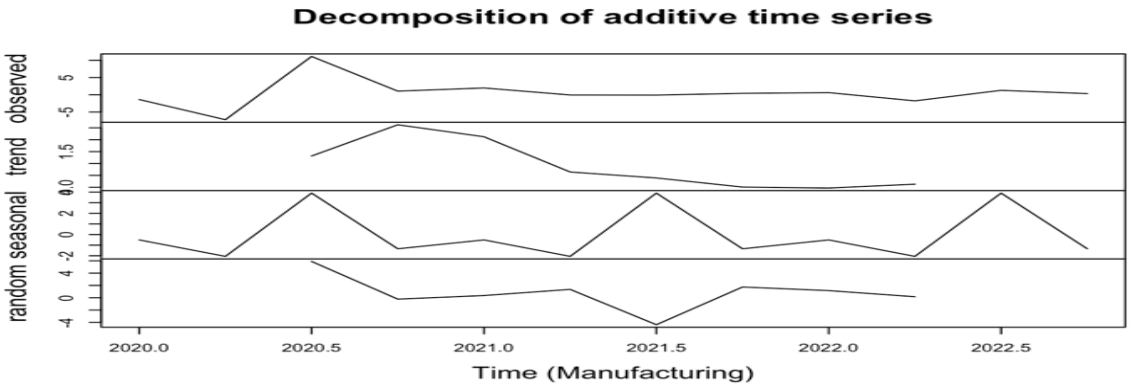


The time series analysis of different economic indicators is displayed here. From the graph, it is clear that there has been some event around the end of Q1 of 2020 as almost all the predictors have decreased the value during that time (First covid wave and lockdown). After then there has been a sudden increase when the economy was trying to stabilise itself. Starting from 2021 the economic indicators try to become stable with some ups and downs.







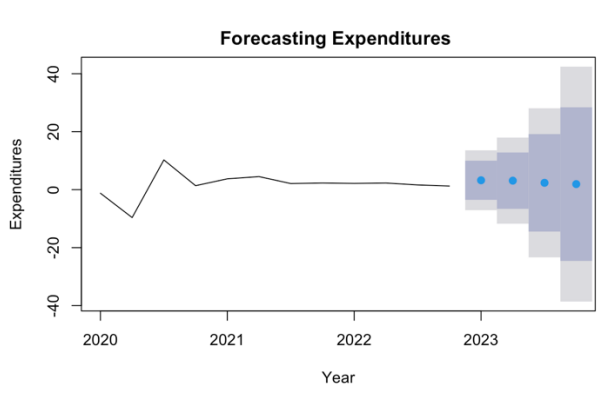


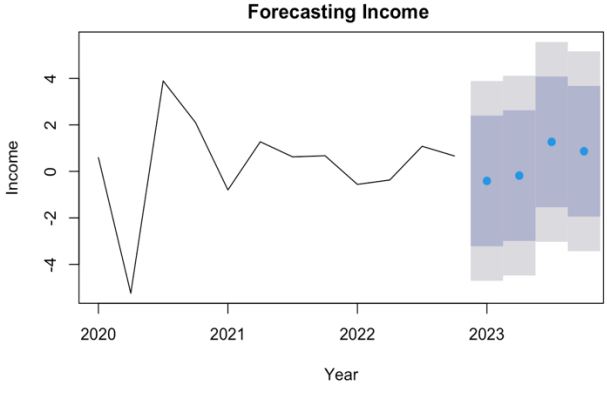
From the above graphs we can see all the economic indicators are seasonal, for the trend Employment, Production, Expenditures all seems to be decreasing over time but at a very steady rate and with Manufacturing and Income seems to be on an increasing trend.

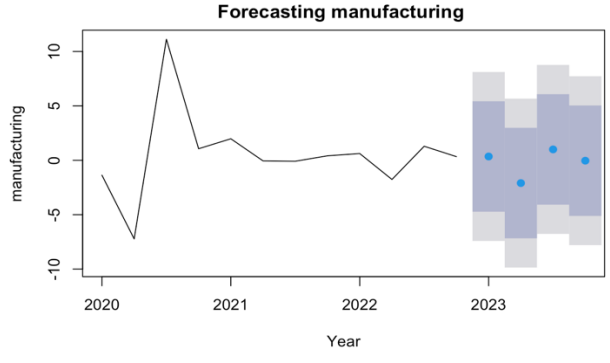
For economic indicators such as income, employment, expenditures, and manufacturing in Q4 2022, the percentage change seems to be positive only. The only indicator “production” seems to have a negative value suggesting some recession trend. With the observation of the trend and Q4 per cent change, we can say that the USA might not be heading towards a recession.

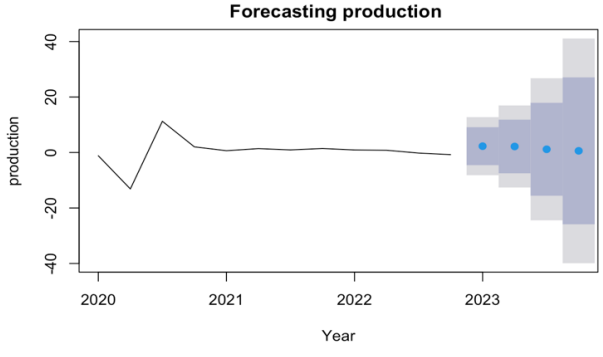
5) Future Prediction

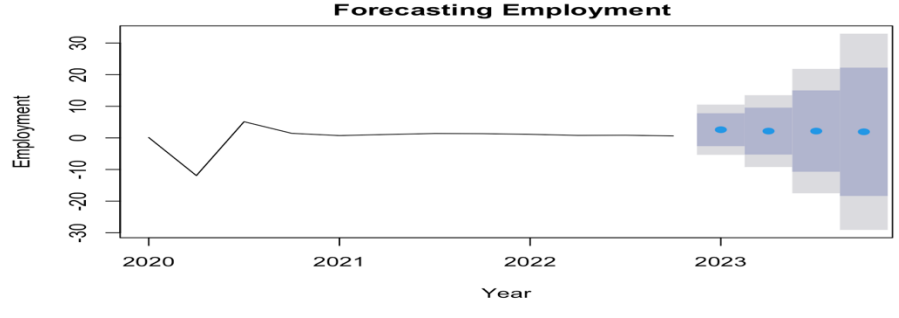
The future predicted values for the US in 2023 can be seen from the following curves,











Future Projected values for 2023	Point Forecast	Lo 80	Hi 80	Lo 95	Hi 95
Production	0.5938325	-25.881416	27.069081	-39.896566	41.08423
Employment	1.929557	-18.353227	22.212340	-29.090283	32.94940
Income	0.8661656	-1.942965	3.675297	-3.430029	5.162361
Expenditures	1.916201	-24.580263	28.412666	-38.606645	42.43905
Manufacturing	-0.03745347	-5.113012	5.038105	-7.799851	7.724944

From the forecasting plots and the table it can be seen almost all the values are in the positive zone and only manufacturing seems to be going in negative with only -0.03%, there is no confirmed indicator that the US might go into recession in 2023

6) Conclusion

From the clustering data, we observe that some of the states might be heading into a recession. From the Time Series Analysis and forecasting some of the indicators suggest that the US is going into the recession but mostly all the indicators suggest that the US is not heading into the recession in 2023.

Additional data and analyses

To determine if the U.S. is in or entering a recession, it would be beneficial to analyze additional data and conduct further assessments. Some examples include evaluating consumer confidence, which is a crucial indicator of economic health. Housing starts and building permits are also important since they can provide insight into the broader economic picture. Business investment, particularly in capital goods, can indicate business confidence about the future of the economy. Interest rates are also vital since the Federal Reserve uses them to manage the economy. Finally, the consumer price index (CPI) measures changes in prices of goods and services over time, and it can indicate whether the economy is overheating or cooling down. To provide a complete assessment of the U.S. economy, one must evaluate multiple economic indicators, including employment, income, expenditures, production, and manufacturing, in addition to the above-listed factor.