# Helping Predict Momentum in the Economy

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## Abstract

Over the past 12-14 months it seems that economists, financiers, journalists, and many other professionals are certain of the fact that the US economy is headed into a recession. The US stock market had a notable negative year over the course of 2022 and the first quarter of 2023 has been filled with headlines about companies laying off thousands of their employees. Recessions are seldom easy to predict; however, there are a variety of different social and economic data points that can be used to predict downturns in the economy. There are innumerable metrics that financiers and investors look at to try and predict movements in the market and the economy. Nonetheless, we will be looking at some of the most closely followed and popular metrics like CPI (Consumer Price Index), PPI (Producer Price Index), Nonfarm Payrolls, Unemployment, Initial Jobless Claims, and potentially a few more. All this data is readily available through the US Federal Reserve's economic data portal called FRED (Federal Reserve Economic Data). Our goal would be to pull the historic economic data for the metrics mentioned previously and compare those to previous downturns or uptrends in the economy to display what has historically been a leading indicator of whether the economy will remain strong or start to weaken going forward. We would do this through our visualization that shows historical economic data plotted over time and compare that against growth in US GDP. Our visualization will include functionality to allow the user to add or take out different data points from the visualizations or change the period that they are looking at. The end goal of the visualization would be to make it easier for professionals and consumers to understand how changes in economic data affect the economy.

## 1 Introduction

The domain task that our visualization or visualizations support is the analysis of economic data and the correlation between those data points and the health of the overall economy. Many times, this analysis is ultimately used to predict moves in the stock market. However, that is an ancillary use of this analysis and not something that we are focusing on with our visualization. It is important to support this specific domain task because the US economy is the largest economy in the world and when it moves in one direction the rest of the world tends to move in an identical fashion. Therefore, in our visualization we are looking to have multiple line charts showing a variety of different economic metrics like CPI, PPI, nonfarm payrolls, etc., against the growth of the US economy. We will have a slider feature where the user can change the time period that they are looking at as well as a toggle feature for each data point so the user can pick and choose which data to add to the chart from a menu of different economic data points.

The visualization does not only help active participants in the stock market, but also aims to be a useful tool for students and researchers who are looking to see and understand how economic cycles have looked historically and if there are any patterns in the data that were not known previously.

Again, all of these correlations are meaningful to find because an economic recession can lead to millions of people losing their jobs, increases in gasoline and food prices, and higher home prices. Because of this, knowing when an economic recession is going to occur before it happens can potentially lessen the impacts to millions of U.S citizens. For example, another result of an economic recession is the collapse of the stock market. Therefore, if an investor knows when a recession is going to occur, they can get out before the market crashes.

As many of us college students are taking out loans or investing in the stock market, the knowledge of an incoming recession would help us all out and save us from a potential costly situation. Not only college students but an economic recession would affect everyone in one way or another.

We want to look at data from previous economic recessions and compare them with each other as well as present day. This will help us build an understanding of the economic factor that can lead to a recession By looking at previous patterns of data, we can use them to predict what potentially could occur in the future.

## 2 Related Work

The objective of the visualization is to allow users to view economic indicators both in the present and past to view correlation or potential causation in order to possibly predict a recession.

A similar commercial visualization aiming to educate viewers on the current economic state of the world is provided by Bloomberg. Bloomberg provides constantly updated Global Economic Indicators in a similar manner to the desired product of the visualization[1]. We will utilize similar visualization strategies to educate users of economic indicators and how they can be used to predict economic wellness. Our visualization draws inspiration from Bloomberg in our selection of economic indicators with additional interactivity and provided context for historical events such as the economic downturns in 2008 and 2020.

Gunawardane et al. analyze socio-economic indicators across the globe to recognize the level of development in a country and how it may impact international policy creation[2]. Our visualization aims to show economic indicators to allow for education and possible impact on business and political decision-making.

The work of Estrella and Mishkin on predicting United States recessions with financial variables as leading indicators provided guidance on the nature of economic indicators in predicting economic behavior of the United States[3]. While our visualization will not provide recession predictions for the future, we aim for our users to educate themselves with the visualization and possibly

draw independent conclusions on the potential future of the economy. Estrella and Miskin analyze the performance of indicators such as interest rates and spreads, stock prices, and monetary aggregates in predicting future recessions, these performance statistics and their comparison to other financial and nonfinancial indicators allow for our visualization to have truly causative indicators instead of simply correlative indicators that may mislead our audience.

## 3 USE CASE

To demonstrate which factors are most impactful to an economic recession, our tool will compare the patterns today with previous recessions. All the data used will be pulled from the Federal Reserve Economic Data (FRED) to ensure accuracy. Our end users of our tool would be anyone interested in the economy and financial markets. This would include students, professors, economists, etc. For our users to get a better sense of the state of the economy, we want our users to be able to look at our visualizations and instantly draw conclusions.

When looking from an investor's perspective, the longer they stay invested in the market during a recession the more money they lose. By using our tool, the user would be able to avoid this and get out of the market before it crashes. Which would drastically save their investment. Whether it be a retirement fund or personal portfolio.

### 3.1 Domain Tasks

Domain task 1:
Analyzing the state of the economy and financial markets by comparing current economic indicators with those from previous recessions to identify patterns and trends.

Task abstraction:
This task involves analyzing economic data and visualizing it in a way that helps users understand the state of the economy and financial markets. The task requires comparing current economic indicators with those from previous recessions to identify patterns and trends. Users may need to filter and manipulate data to extract relevant information and visualize it effectively. The high-level abstraction is to present the information. The medium level abstraction is to search by browsing, since the location is known but the target is not. Finally, the low-level abstraction is to query by comparison.

Domain task 2:
Making informed investment decisions during a recession by using visualizations to identify signals indicating a potential market crash and adjust investment strategies accordingly.

Task abstraction:
This task involves using visualizations to monitor the performance of the stock market and identify signals that may indicate a potential market crash. Users would need to interpret these signals and make informed decisions on adjusting their investment strategies to minimize losses. The task may involve filtering and manipulating data to create custom visualizations tailored to the user's investment goals and risk tolerance. The high-level abstraction is to present the information. The medium level abstraction is to search by browsing, since the location is known but the target is not. Finally, the low-level abstraction is to query by identifying what changes in investments were successful in the past.

## 4 DATA

Our data comes from the Federal Reserve Economic Database (FRED). Which is the most widely used source for US economic data. The US federal reserve has been collecting data points around the economy, inflation, energy prices, etc., for over 100 years and has consolidated almost all of it onto FRED. One of the most important parts of data that is posted on FRED is it is basically 100% unbiased. Most of the data points are purely quantitative and leave almost no room for input error or user bias. Also, since this is a government-controlled data provider the data is quite clean. There are almost 0 errors that you will find in any of the data sets that we will be using for this project.

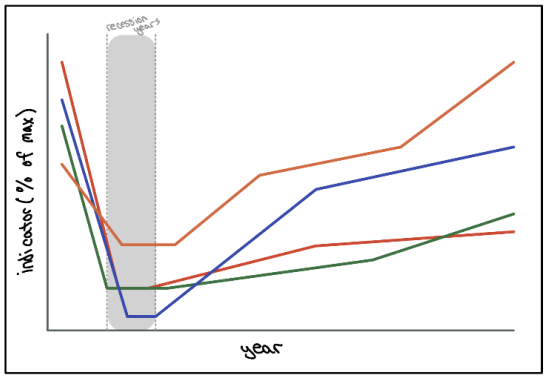
One problem that the user can run into when using FRED as a data source is you will often find datasets broken by state or by a certain industry and not all aggregated together. This can be a small issue if you are trying to prescribe a correlation seen in a dataset from a given state to the entire nation. However, if you do more digging through all of their datasets you can usually find one that is national. If you can not, you might have to not use that data point. However, given the breadth of data that is offered on FRED it is not really an issue to go and find another piece of data. I have pasted three example sets of data below that we are planning on using for our visualization. The first is Urban Consumer Price Index, the second is Industrial Sector Producer Price Index, and the third is US Nonfarm Payrolls.

Urban CPI: https://fred.stlouisfed.org/series/CPIAUCSL
Industrial PPI:
https://fred.stlouisfed.org/series/PCUOMFGOMFG
Total Nonfarm payrolls:
https://fred.stlouisfed.org/series/PAYEMS
Unemployment Rate:
https://fred.stlouisfed.org/series/UNRATE
Unemployment Claims: https://fred.stlouisfed.org/series/CCSA

In terms of cleaning required for the data sets above there is virtually none. The only problem in terms of cleaning that we think we will run into is the difference in units between one data set and another. For example, nonfarm payrolls is shown in thousands while other pieces of data may be shown in millions. Besides that, we do not foresee any cleaning issues in the data sets that we use for our visualization.

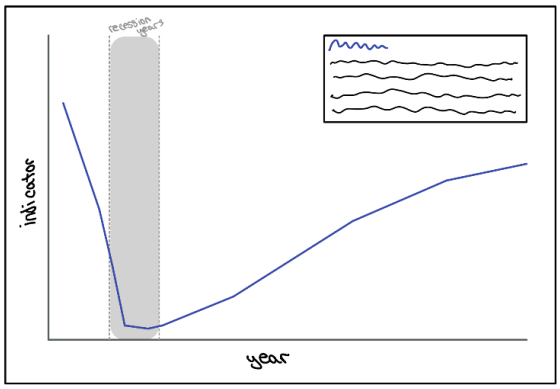
## 5 Design Process

**Sketch #1**



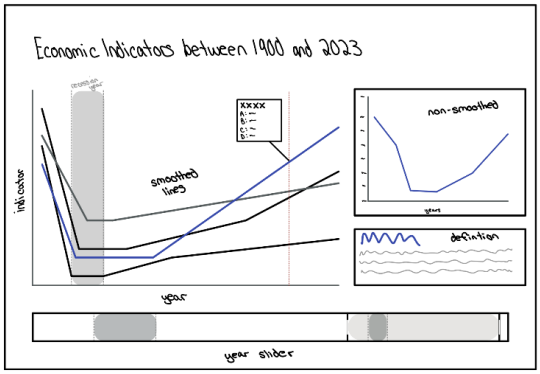

Our visualization aims to educate users on how economic indicators can warn about impending economic recessions. To represent all values relative to each other, values for the main graph will be shown as percentages of the maximum value achieved between 1900 and 2023 with values smoothed for readability. Users will also be shown if there are any years classified as a recession in the year range they chose.

**Sketch #2**



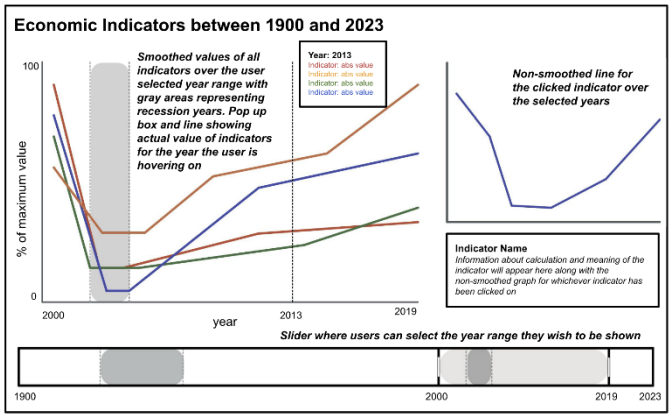

When a user clicks on a line on the main graph they will be shown a graph with the chosen indicator with the actual values for that year range non-smoothed for more detailed investigation. The user will also be shown a pop up describing the calculation and meaning of the chosen indicator to further our mission of education and increasing economic awareness.

**Sketch #3**




This is a general sketch of the full dashboard; we will have the main visualization from Sketch 1 linked to the year slider showing depression years where users will choose the year range of interest. It will also be linked to the visual shown in Sketch 2 but the information box will be separate for readability uses. The user will also be shown the actual values of all indicators in a pop-op for the main visual depending on where they are hovering.

**Final Sketch**




Our final sketch has three main components, the main visual, slider, and detailed visual with the accompanying information box. We felt that all of the visuals represented in our sketches added value for the users so we plan to implement the aspects present in Sketch 1-3 for the final sketch.

The main visual has many of the same aspects as Figure 1, we will show the color-coded indicators as a percentage of the all-time maximum value and smooth the values for readability. Years classified as recession years will be colored grey with border to show the beginning and end as well as a black line showing the current year the user is hovering over. The pop-up will display the current hover year as well as color coded text matching the indicators that shows the actual value of the indicators at that point in time.

The main visual is linked to the slider through brushing and linking, the user will drag the beginning and end of the range to select the years show in the main visual and the chosen indicator visual. The slider will also show which years are recessions year using grey shading.

The indicator visual will show the last indicator the user clicked on with its actual values non-smoothed for more specific investigation. There will also be an information box below the visual that describes the calculation and meaning of the clicked indicator to further the mission of educating users of our visualization.

The main visual utilizes lines as the mark, and the channels of color (for differentiation between indicators), tilt (to show severity of change), and position (vertical for the percentage and horizontal for the year). The selected indicator side visual utilizes lines as the mark, and the channels of color (for showing the clicked indicator), tilt (to show severity of change), and position (vertical for the percentage and horizontal for the year). The slider utilizes area for the mark (showing the length of the current year range to be show) and the channel of color to show the selected years (light grey) and the recessions years (dark grey).

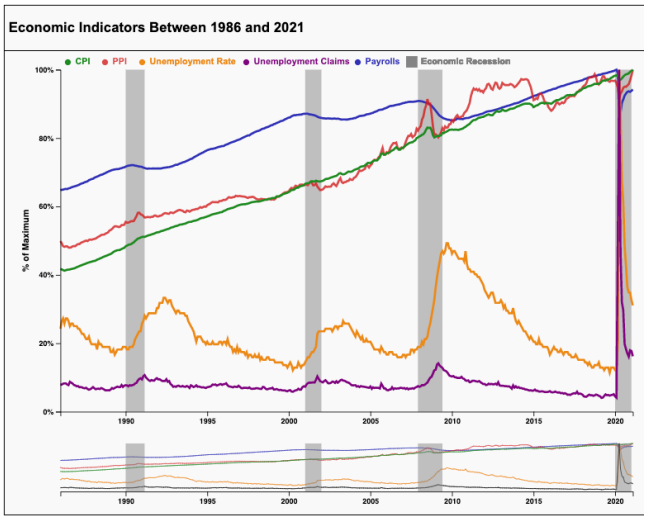
Users will be able to interact with the visual through selecting the year with the slider, hovering over the main visual, and clicking on a line of the main visual to change the detailed side visual.

Usability testing is crucial in the design process as it allows designers to identify issues and gain insights into how users interact with their designs. For our testing, we had users perform tasks that involved each feature of our visualization to ensure that the navigation between the webpage was easy and usable. By

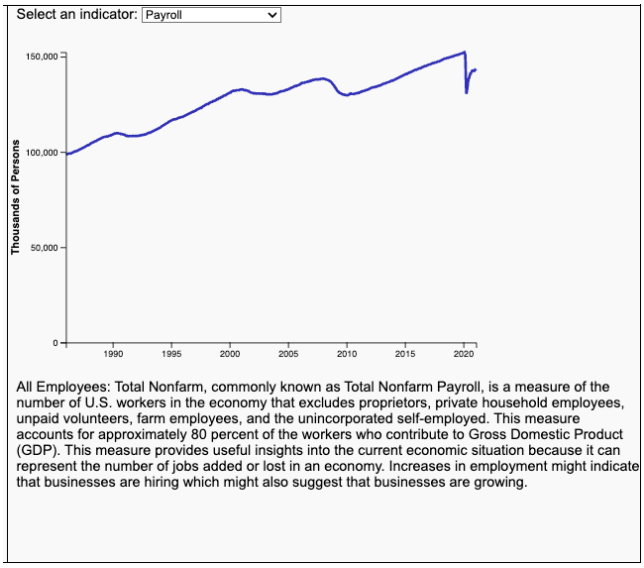
observing users interacting with the design, we could identify pain points and areas of confusion, and then make changes to improve the user experience.

The final visualization design evolved during implementation as users provides feedback. In our tests we found the slider and Y-axis labels were areas of difficulty in understanding. We added more information to the identifier information as well as adding a demo video, so the functionality of the slider is clear.

## 6 Final Design




Explanation: We tried our hardest to design our main tool in a way that the viewer or user can flexibly view historical trends in economic data and compare those to time periods of previous recessions. You can see in the picture above that we crated our main visualization in a way that all the data points are comparable to each other with the 5 colored lines, and you can see how those data points have moved during periods of recessions which are represented by the grey bars. It was also a major point of our design process to have functionality in our visualization where the viewer could change the time that they were looking at to get a closer look at a certain period of the data. We did this through a time range slider on the bottom of our main viz which you can see above and it exactly mimics the larger chart.




Explanation: We designed our detailed visualization in a way that allows the user to break out a single data point like CPI, or Unemployment Rate to get a closer look at what that data point has looked like historically and to also get a detailed description of what the data point is and how it is calculated or tracked. We also wanted there to be functionality in the second visualization where the user can choose which data point they are looking at and you can see that incorporated in the drop-down menu in the top of the above picture where the user can select an indicator to view.

In terms of how the user can use our webpage and visualizations to address the domain problem that we are trying to solve which is to view and understand trends in economic data over time and compare those to previous recessions, the view can first start by looking at the main visualization. In the main visualization, the viewer can see how lines like unemployment rate and unemployment rate move in tandem with unemployment claims having a slight lead on the unemployment rate. They can do the same with PPI and CPI to see that these two lines not only move in tandem with each other but also almost always spike either before or during periods of recession. After understanding how different data points are correlated with each other the user could then ask what these trends looked like before and during the great financial crisis of 2008. To answer that question the user could go to the range slider below the main viz and select the 2008 recession and the period before it to get a more detailed view of how economic data changed during that time period. After doing this if the user wanted a more in depth understanding of the 5 economic data points shown on the main visualization they could go to the detailed viz to see that data point broken out with a description of what that data point means and how it is calculated or tracked.

## 7 Discussion

Upon reflection of the final visualization tool, it has successfully met the design goals that were set. The tool's primary feature enables users to track trends over time, and the slider feature allows users to focus on specific periods. Additionally, the small visualization on the right provides users with a more precise understanding of the implications of individual indicators.

However, it should be noted that while the tool effectively solves the domain problem of exploring economic data during times of recession, it could benefit from additional indicators. As many variables contribute to a recession, the inclusion of more indicators could enhance the tool's functionality. Additionally, the tool currently lacks the GDP indicator, which is a crucial metric for economic analysis. To improve the tool further, allowing users to compare indicators directly would be a valuable addition. This could be achieved by providing users with the option to select specific indicators to display in the primary visualization instead of displaying all indicators simultaneously. This enhancement would offer users greater control over the data they analyse and enable them to make more informed decisions based on their research.

In conclusion, while the final visualization tool has met its initial design goals, there is always room for improvement. Incorporating additional indicators, offering more user control over the displayed data, and adding interactive features are just a few of the potential enhancements that could improve the tool's functionality and user experience.

## 8 Conclusion

The goal of our project was to create a visual that shows which economic indicators are most influential to an economic recession. We looked at economic data from the Federal Reserve Economic Data (FRED) to create our tool. More specifically, we looked at: Payroll, CPI, PPI, Unemployment claims, and Unemployment Rate. We compared the patterns of the different indicators before previous recessions and seeing if we can use those same patterns to predict a future recession.

For our graph, the marks consisted of lines to display each indicator over time, and the channels consisted of color which differentiated the different indicators. Our tool consisted of a main graph of all of the indicators as well as a side graph that the user could choose with a dropdown. Which graphed whatever indicator the user selected as well as displaying a description of the indicator.

From our tool, we observed that right before a recession, there were increases in CPI and PPI which could be indicative of inflation. During the span of the recession, there were huge increases in unemployment rates and unemployment claims which shows how consequential recessions can be. Lastly payrolls, during a recession there is a frequent pattern of decrease in payrolls.

Breaking down the distribution of work: Tori handled and did an excellent job of creating most of the visuals. Jack did an amazing job of finding and cleaning the data as well as implementing a tooltip. Ellie did a great job with the styling of the graphs and tooltips as well as writing a huge portion of the written report. Lastly, Alex did a great job with the brushing and linking of the graph as well as the filming and formatting the demo video.

**Appendix:**

Data Abstraction:

Each row in the dataset represents a different observation year of the data.

| Date | NonFarm Payrolls | Producer PPI | Urban CPI | Jobless Claims | Unemployment Rate |
|---|---|---|---|---|---|
| Ordinal | Quantitative | Quantitative | Quantitative | Quantitative | Quantitative |

## References


[1] Flanders, Stephanie, et al. "The 12 Global Economic Indicators to Watch." *Bloomberg.com*, Bloomberg, 22 June 2018, https://www.bloomberg.com/graphics/world-economic-indicators-dashboard/?leadSource=uverify+wall.

[2] Analyzing Statistical Relationships between Global ... - IEEE Xplore. https://ieeexplore.ieee.org/abstract/document/5426689/.

[3] Estrella, Arturo, and Frederic S. Mishkin. "Predicting U.S. Recessions: Financial Variables as Leading Indicators." *MIT Press*, MIT Press, 1 Feb. 1998, https://direct.mit.edu/rest/article/80/1/45/57058/Predicting-U-S-Recessions-Financial-Variables-as.