Question statement

Through the given data (Economic Indicators and Eurodollar Outright Market Data) you will have to analyze the below things:

1. How central bank reacted based on economic data points which are given to you.

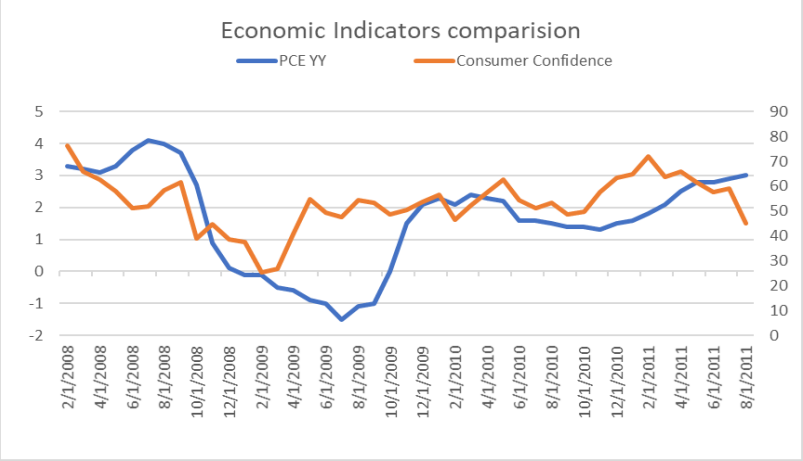
Solving the code

Techniques used-

- Chart of excels to compare between two data sets
- Correlation matrix of diff time interval between different indicators in python
- Plotly graph for visualizing the changes in indicators value during exceptional economic behaviour.

Absolute comparison charts in excel (absolute_comparision.xlsx)

Central banks tend to fix the interest rates based on the various results obtained by economic indicators. Leading indicators tend to move ahead of other indicators.
To compare the behavior between different economic indicators and the fed interest rates, I have drawn the dynamic charts of each of the three central banks' association to see the outward behavior of what changes is observed on one of the indicators due to other. The Excel plot consists of 2 selected economic indicators' behavior between the selected dates. If, in place of one of the indicators, we choose the fed rate and let the other indicator 2 be anyone the given- then we can observe that the increase or decrease of the indicator is having what change on the fed interest rate. It can be seen in any economy, except for some unforeseen situation, leading indicators like 'consumer confidence tends to pave the path for coincident indicators like PCE to follow the same trend, and we can visualize that CPI follows **a similar shape** to the chart as consumer confidence chart **six months before**. This is observed with all economies and is very important in determining policies.



See that Consumer confidence curve is ahead of PCE

Based on graph comparison of the indicators with fed rate between 2000-23, I have bifurcated the indicators whose values are directly proportional to rates and which are inversely proportional-

- Directly proportional- a) Retails sales
  b) building permits(starts in 2004)
  c) consumer confidence
  d) ISM manufacturing & non-manufacturing
  e) PCE and CPI
  f) non-farm payroll(see data in less date span)
- Inversely proportional – a) unemployment rate
- Not fixed- a) avg earnings(MM and YY)
  b) avg workweek hrs

Note- 1)The comparison could not be very indicative in a more extended range. So it is advisable to look through different time intervals for correct behavior. Indicators which do not show any kind of relationship in the long term are the indicators that affect the short-term rates, and their behavior is more defined in significantly less time interval

2) To compare indicators, use the selected indicators only within the range of dates when they came into existence. For all dates where there is no value of the indicator in the given data, it returns a 0 value in graph

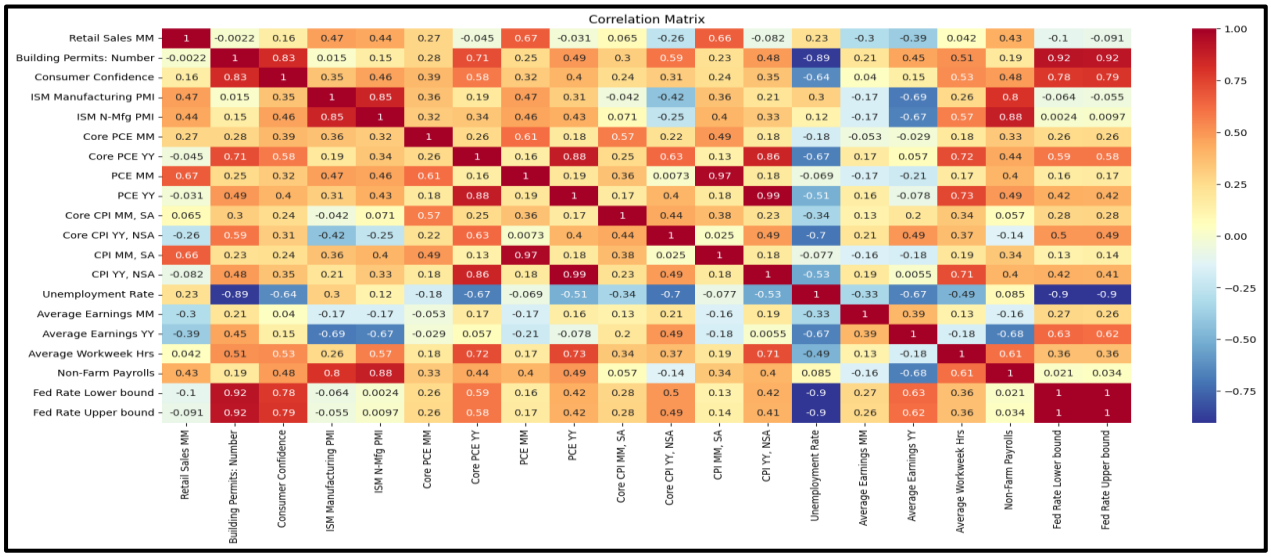
Correlation matrix (in colab notebook fed_activity.ipynb , excel sheet economic_data.xlsx loaded locally)

To look at the approx. Relations obtained by Excel curves and the correlation matrix in Python are beneficial in estimating the ties between the matrixes given. It shows how much the indicator's value depends on others on a scale from (-1 to 1), with 1 implying the perfect proportional relations and -1 implying the excellent inversely proportional link.

My code can give a dynamic correlation matrix when we change the **'start_date'** and **'end_date'** variables. When there is a very high difference between the dates, then we might not seen too much in the value of the matrix, but as we iterate over different dates, we observe the relation of indicators with the fed rate. It is observed that in some instances fed rate is the result of the current value of indicators and also the previous short-term time values of indicators. So it is advisable to look into the data more closely at different times to see which hand has what say in determining the interest rate.

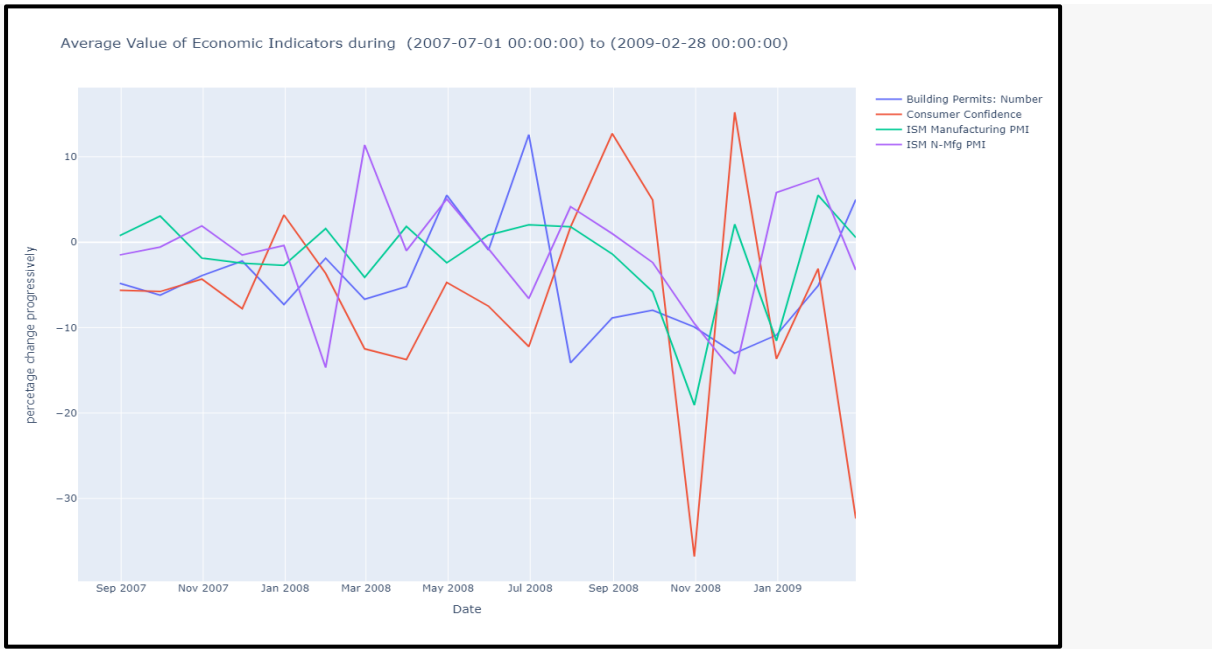
The interest rate changes from the initial value, often due to sudden changes in one or a few indicators. So in the second code snippet of the lab notebook, I tried to see which hand has a relation>0.5 and less than -0.5 to the interest rate in a particular window of months, which can be modified by changing the variable **'month_window**.' With this, we observe that a specific indicator has more say in determining the interest rate. This observation is instrumental during exceptional economic behavior, especially during the great recession and covid times, where sudden expectations of particular indices bring effect on the economy.

Correlation matrix during recession



Plotly graph

A plotly graph is used to see detailed variations of percentage change of indicator value concerning the previous date so that a clear visualization is obtained. Plotly charts can be used with several metrics and uploaded over websites due to their attractive interface. FED result are examined with plotly chart. I clubbed all necessary indicators on a Plotly graph to obtain their relation at different intervals. I skipped a few hands as stored in the 'indicators_to_drop' array because many indicators have high links between them and more or less indicate the same feature. A plotly graph is used by me to see the behavior of indicators highly correlated to interest rate during the recession and high boost period. It shows how each indicator changes with time and can be compared to reach a conclusion. In following code snippet, I examined the values of leading indicator when recession was approaching to show how leading indicators indicate the future situation of economy.



See that majorly indicators value changes remained on negative side at wake of recession

Note- . As excel sheet economic_data.xlsx is read by loading locally so it is advisable to change the address in pd.read_excel(' ') as the location of file in viewer system)

US central bank

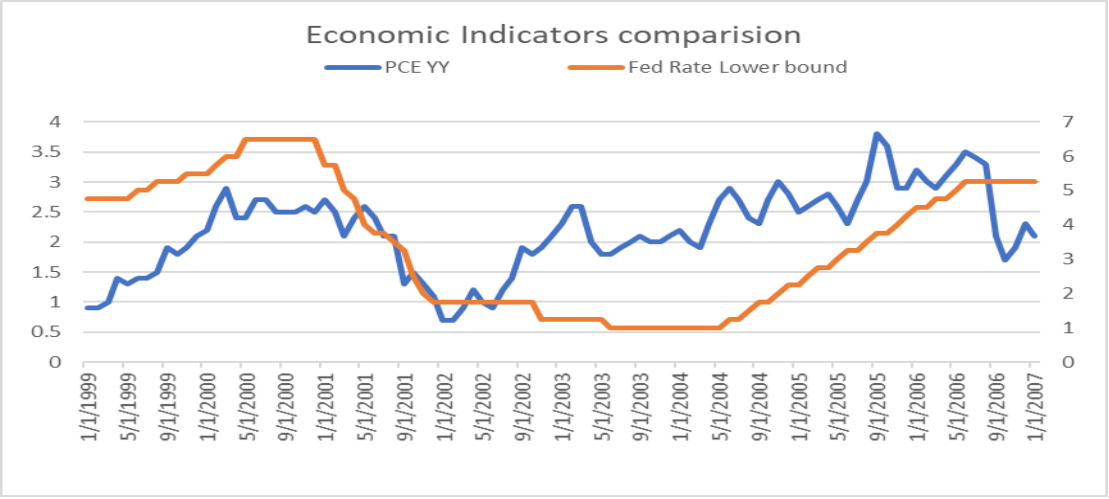
The central bank of the USA is FED which is responsible for monetary policy, having a mandate for the stability of prices and keeping the country's employment at a healthy rate. For this, the tool the central bank has is setting up fed rates with two values- upper rate and lower rate. Fed rates are set up after evaluating the indicators values released monthly basis. So let's analyze fed decisions at various stages of the economic cycle in the last 20 years.

From 1995-2000

The US economy was in a good situation during this period, and the fed rate was constant at around 5% until 1999, when provided increased cut rates by 50 basis points due to negative values of indicators on a short-term basis. But Fed hiked the rate in 1999, evident as inflation was walking, which is visible by the CPI MM- Fed rate graph. CPI values were on a spike, so FED hiked the rate from 4.75% to 6.25% by 200 with an increase at a slow pace.

From 2000-07(put dates of comparison from 1999-07)

At the start of the 21st century, the USA was in a situation of deflation, with PCE values at constant fall. The unemployment rate was also increasing. ISM manufacturing and consumer confidence, which are the leading indicators started the downward movement in the graph from the start of 2000. So at the end of 2000, FED began to decrease the interest rate, and the rate fell continuously till the end of 2001 such that rate which was ta peak at 6.5% at the start of 2000, came down to 1.75% at the beginning of 2002. After constant values for a few, FED still cut the rate because, with the PCE MM graph, we observed that the inflation situation was not improving. This was the stage of recession in the US economy. The economy recovered from this situation in 2004, and after this, FED continued increasing rates until the global recession came.



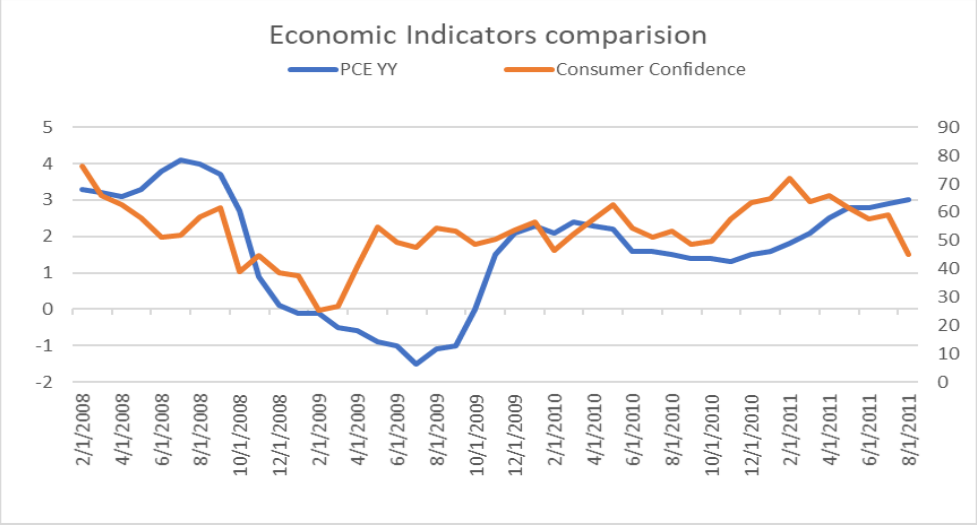
Fed activity at start of 21st century

Economy behaviour during Global Great recession (2007-11)

Officially the great recession lasted around 19 months in the US, from December 2007 to June 2009. Still, the impact of the recession lasted much longer, which was the critical reason for FED maintaining the 0 interest rate till 2015.

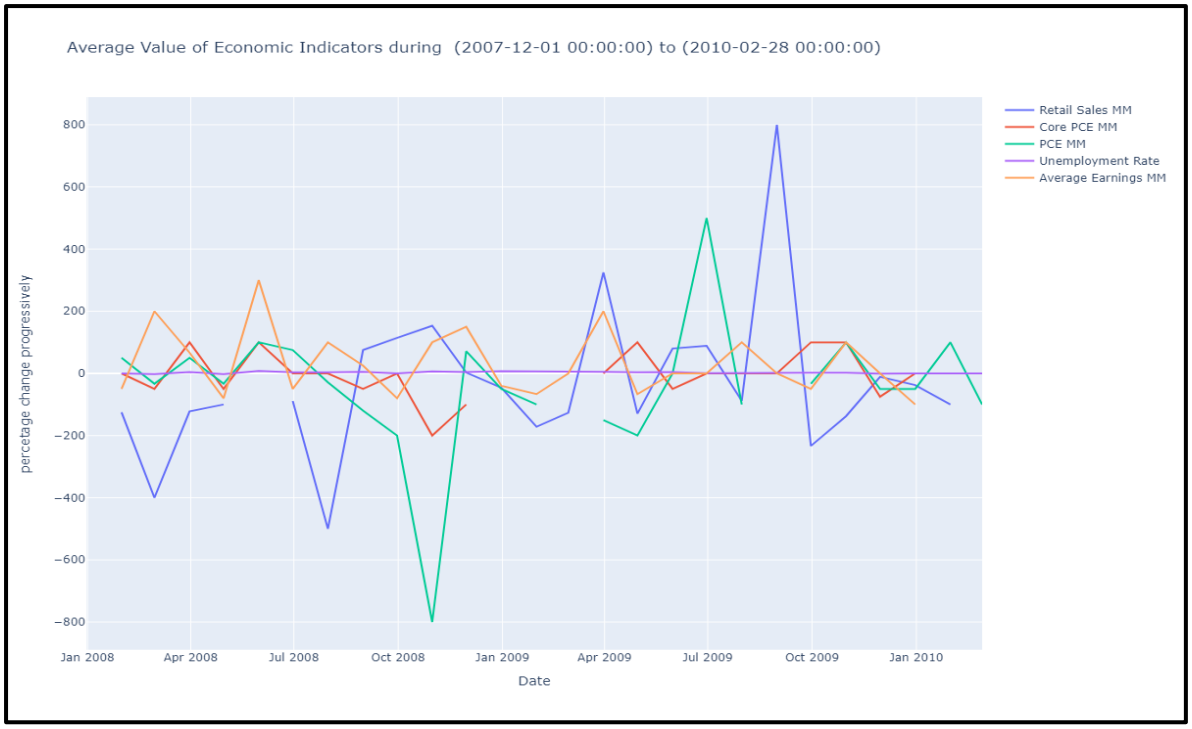
Leading indicators are the keys used by economists to predict a recession. With the data given, the principal leading indicators –Building permits, consumer confidence, ism manufacturing, and non-manufacturing data. In the following code snippet of file 'fed_Activity.ipynb', I tried to look closely at the percentage change in monthly data of leading indicators while leading to recession. The data for better understanding is chosen to observe the 2007 dataset as the end-of-year downturn hit. We follow that leading indicators value percentage change is clearly negative, indicating that the economy is falling continuously. Consumer confidence was constantly decreasing. Also, such steeper falls in releasing other leading indicators were hardly observed in the last few years. The decrease in one month was often comprised the other month, but there is a steep decrease here, and the fall continues. So these leading indicators were beneficial in determining the start of the great recession.

Note- . As unemployment is already presented as rate so the changes in rate would be very small therefore it is advisable to look at unemployment rate change after hiding the other indicators matrix which can be done by clicking at their legends.



See how consumer confidence predicted fall of economy

Coinciding indicators behavior is seen in the following code snippet. Here I observed the percentage change in the indicators value return compared to the previous month. The indicators used are- Unemployment rate, PEE, Retails Sales, and average earning MM. The main impact of the recession, which was looming worldwide as indicated by leading indicators, was seen in this duration. The unemployment rate was a continuous increase. The unemployment rate was at a time high of 10% at the start of the recession.



See the percentage change values of indicator remained negative throughout recession while unemployment rate was increasing

FED action-

FED was continuously increasing the fed fund rate till October 2006. It is important to note that hardly FED maintained a constant rate from 2004-06 till it reached its peak of 5.25% in October 2006. As observed from leading indicators data, smells of recession started coming from the end of 2006 when consumer confidence percentage change first hit a negative sign. This was when FED followed a constant rate policy. The interest rate remained at the peak of 5.25%. This interest rate continued to be on the release board till November 2007- a month before the great recession was officially set to hit the USA.

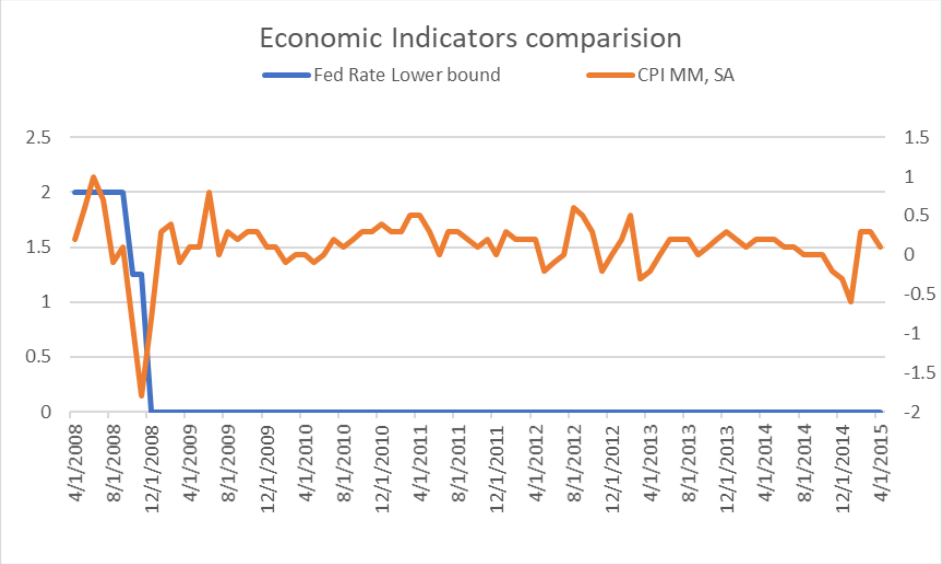
Usually, when the economy needs a little spur, the FED cuts are rated by 25 basis points only, as seen in the past till 2007. But in December 2007, the Fed interest rate was cut by 75 basis points at the start. The FED rate was at a constant decrease from then. It reached 1.25% on October 2008. In December 2008, FED moved to its historic zero interest rate policy, which it decided to continue to combat the country's economic downgrade.

Here FED used quantitative easing and bought several corporate bonds. The subsequent increase in investments is expected to affect employment and consumption positively.

Why ZIRP till 2015

The economic Recession has a significant impact on the economy. Every indicator fell to all-time negative levels during the Recession. If we observe the absolute comparison graph

between two indicators which I did in worksheet US of Excel file named- **'absolute comparison** between dates from 2005 to 2015, we see that though consumer confidence was increasing after the Recession officially ended, the other indicators, e.g., building permit, NFP, etc. were still lower than their absolute value observed before the Recession (can follow with the comparison graph in US worksheet by keeping the suitable parameters within the selected period). At the same time, the unemployment rate was still above 6%, which indicates to the FED that more easing monetary policy is required to combat the effects of the Recession. Also, GDP growth was not increasing with significance with its quarter returns. So till 2015, when the economy felt to be recovered, FED increased the rate. The FED was very cautious with the increase and tried to maintain the FED rate to value for a few months and then increase with a progression of 0.25%.



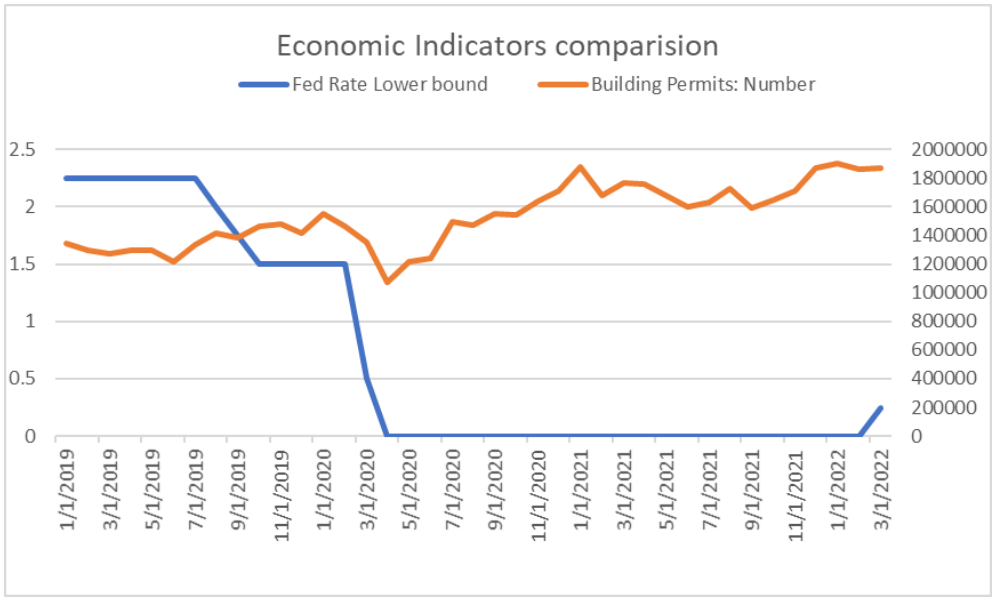
Recovering from recession (2015-20)

FED increased rate in steps and reached above 2% in 2019. Unemployment rate was giving positive response and it came under 1%.After this, FED cut the rate once, which can be made out due to lower inflation as observed with fall in CPI and PCE curve. But after one decrease, FED kept rate constant till covid hit.

Covid Effects

This was the situation for which the whole world was not ready. As a result, no leading indicators showed the sign of what was expected further. When the lockdown was first imposed in the US in May 2020, the unemployment rate spike was the greatest in US history. Every else indicator has an instant downfall point, which we can observe when the curve is selected for the whole duration data of 1994-2022. FED had no option but to bring an instant cut of interest rate. Again FED brought the rate to 0%. Because of this, the low values of the indicator did not last long. In the correlation matrix of the Python code, we observe that the unemployment rate had as large as 0.91 relations to the fed rate in a negative direction. It is to be noted that **the 'Building permit number** 'did not follow its average trend during covid time. Usually, the BP number is proportional to the rate, but it followed inverse values as high as 0.84 correlation here. The same can be observed in the dynamic graph between a building permits and FED rate, where only during this time did they folwed inverse behavior. This was

due to large permits given during covid times which the central bank thought would be a way to boost up other matrices.



Building permit increasing highly after end of lockdown while rate remain 0

Post covid

FED recovered from covid effect at the start of 2021. From then Fed is continuously increasing rates. It is the most extended duration, where FMOC meetings always end with a spike in interest rates. Only in June 2023 did Fed maintain its interest at a constant 5.25%. This was because of a good return of indicators with always positive responses. Inflation was at higher values, the unemployment rate kept decreasing, retail sales were high, and building permits remained t the high values achieved during covid. Also GDP growth was high though after second wave it slown down.

Near future Expectation

As of the current situation, leading indicators are not showing many falls, which implies that the expansion of the economy is expected to continue in the near future.

Analysing UK Central bank Data

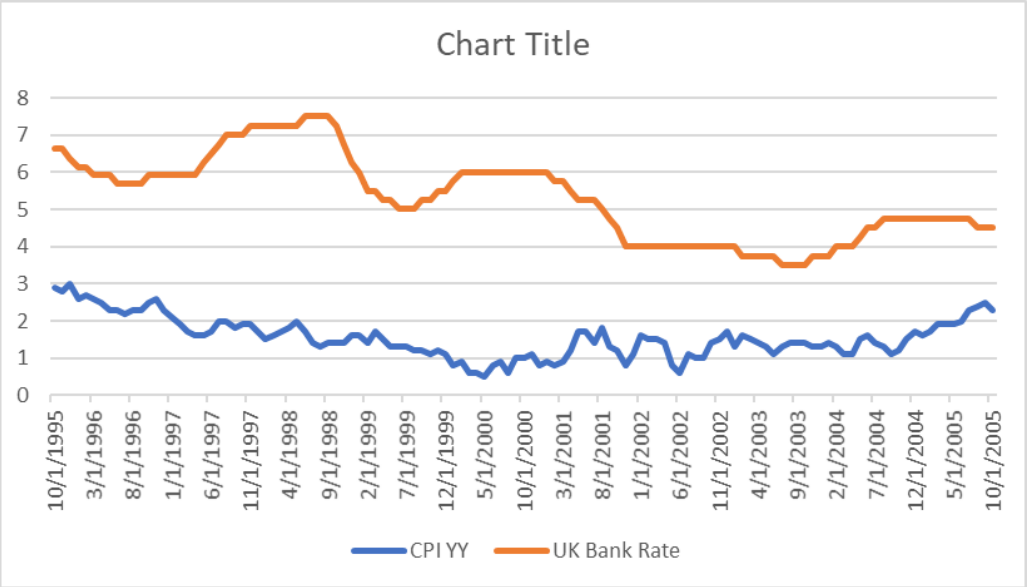
Bank of England(BoE) is the central bank of the U.S.A. Because of the global crisis, the behavior of all central banks are similar, but to look at local advancement, we need to analyze the central bank of the U.K. as well.

The workbook in of U.K. in the ‘absolute_comparision’ Excel file contains the details of comparing any two chosen indicators on the selected dates.

Looking at economy form 2000-05-

UK bank rate used to be above 5% in all data provided from 1984, but in 2001, when BoE started decreasing the BR, the first time the UK bank rate fell below 5% in November 2001. This was done to reduce the inflation increase. Compared with CPI

MM, we see that it had a positive value from 2000-01, which means that there was constant growth in inflation, and to combat inflation, BoE has to make decisions. Other indicators like Retails sales and Consumer confidence, which is said to be the leading indicator, are at a lower point. It is to be noted that the UK unemployment rate was at a constant value of around 6%, and it was not the reason for the rate cut.



CPI vs bank rate in 1999-05

In 2003- after maintaining the constant rate of 4.75% till 2002. BoE again cut their interest cut of 0.25% to combat the sudden falls in indicators values.E.g., Retails sales fell from 4% in the last quarter of 2002 to -0.6 in the first quarter of 2003. BoE maintained this low rate of 4.5%.

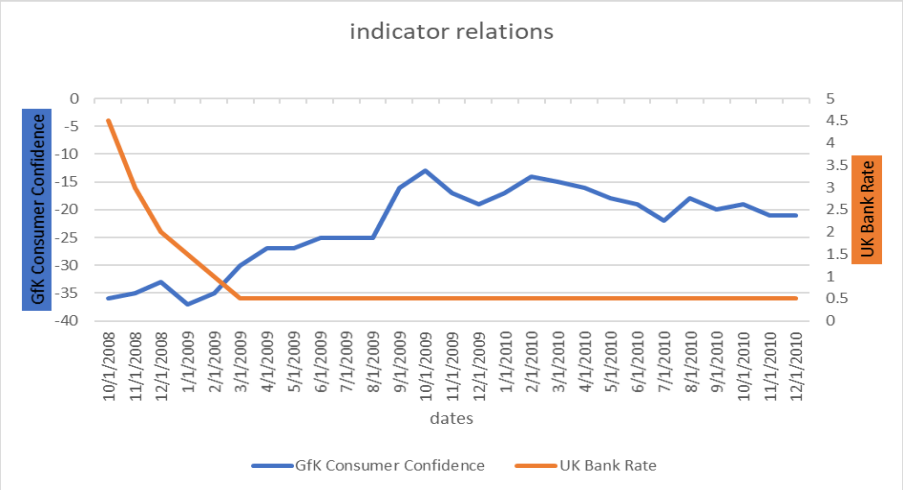
From 2005-07

Nothing big mishap in economy happened during this period. Economy indicators responding positively and BoE maintained its interest rate to 4.5%. after good indications, in 2006 fed started increasing rates with 25 basis points till 2007 when recession hits/

Great recession (2007-10)

Looking at data from the start of 2007 to 2010, we see that the decrease in leading indicators' value initially suggested a recession coming. BoE decided to ease lately after the end of the last quarter of 2007. BoE was not decreasing rates extensively compared to FED and maintained it at 5%, but after the first quarter, indicators released showed a deplorable situation of the economy. Consumer confidence fell drastically from -13 to -40 value. The unemployment rate was constantly increasing with a steeper slope. In August 2008, BoE reduced the interest rate from 5% to an all-time low of 0.5% in Feb 2009. At this stage, BoE applied QE in the economy and bought corporate bonds to combat the recession. So an instantaneous surge in economic activity was observed after this but soon returned to low values. Due to this

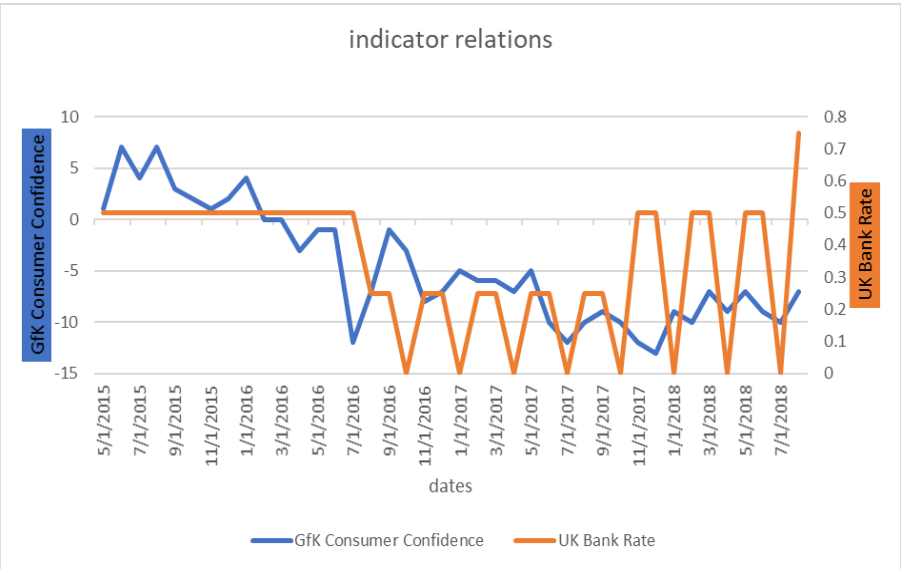
late decision, the recession in the Uk ended in the world in mid-2010 when GDP growth returned to a positive value. Economic indicators needed to show better results throughout the recession. The unemployment rate remained at a peak of above 8% till the end of 2010, and it increased to 8.5% in 2011. Consumer confidence also remained at its negative values. Due to this, BoE maintained this low rate for a very long period.



See the spike in 2009 during recession, due to QE policy

Brexit effect-

In 2016, Consumer confidence was at a positive value first time after the recession. The unemployment rate was already decreasing at a constant rate since 2014. When everything seemed optimistic for BoE to start the tightening policy, Brexit hit the UK economy when it decided to leave the EU. The central Bank again decided to cut the interest rates to 0.3% after the first quarter of 2016, when the indicators(except unemployment rates) started showing sudden falls.There were constant fluctuations in interest rates after this, but the UK economy never looked at a good pace, and it appeared stagnant until covid hit.



See the falls in economy due to Brexit 2016

The Covid-19 impact

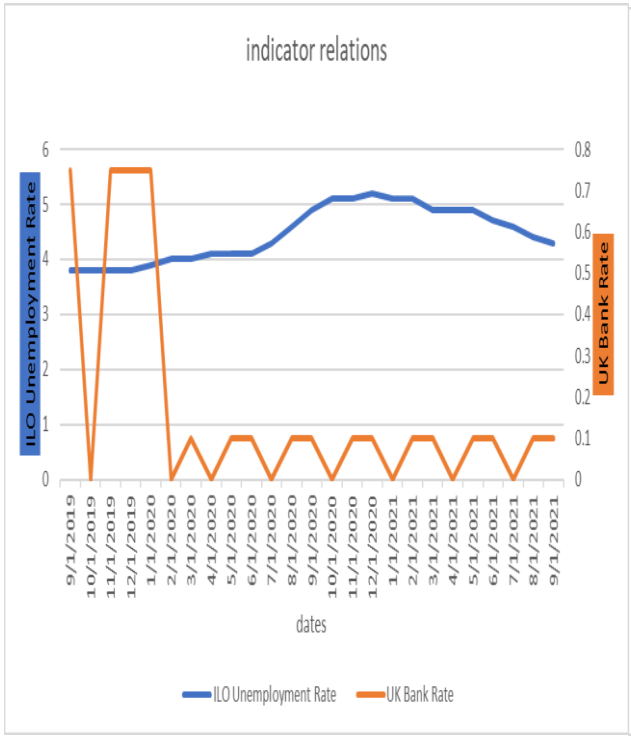
Covid brought unforeseen situations; the indicators released showed drastic changes never seen before. The UK made vital decisions and got the interest rate to an all-time low of 0.10% so that the economy could move to a recovery path quickly. The unemployment rate never raised with that rate as compared to the great recession. Retail sales, the CPI chart, is also not showing maintained at a low value. Inflation was in control, and retail sales were at increase post-lockdown.

Post covid

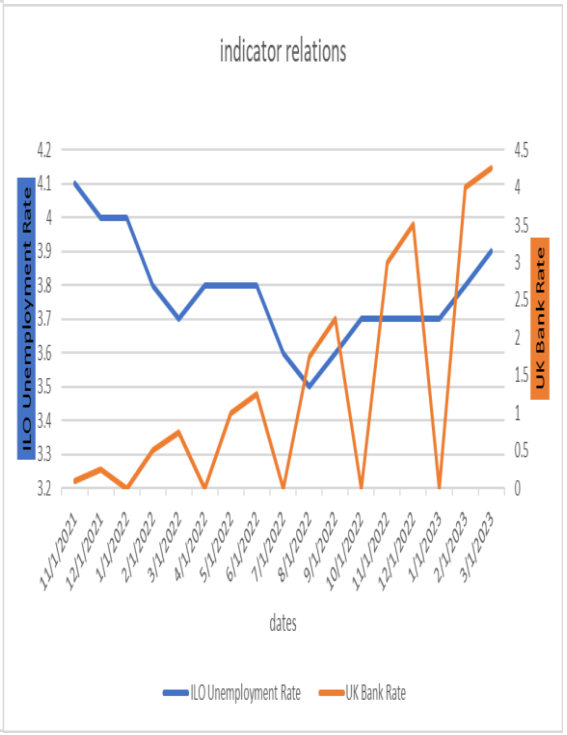
The UK economy showed growth rapidly after covid, and the interest rates were getting above 1% first time after the great recession of 2008. The monthly GDP rate was around 0%, but it did not show great falls as seen in other economies. The unemployment rate fell below 3%.

A future prediction-Leading indicator is consumer confidence is at present showing a low value of around -40, the same as during the great recession, indicating that the UK may again see a recession in near future.

Note: Used the comparison chart in workbook uk of 'absolute_comparision' excel file with different duration and selecting indicators accordingly for analysis



During covid



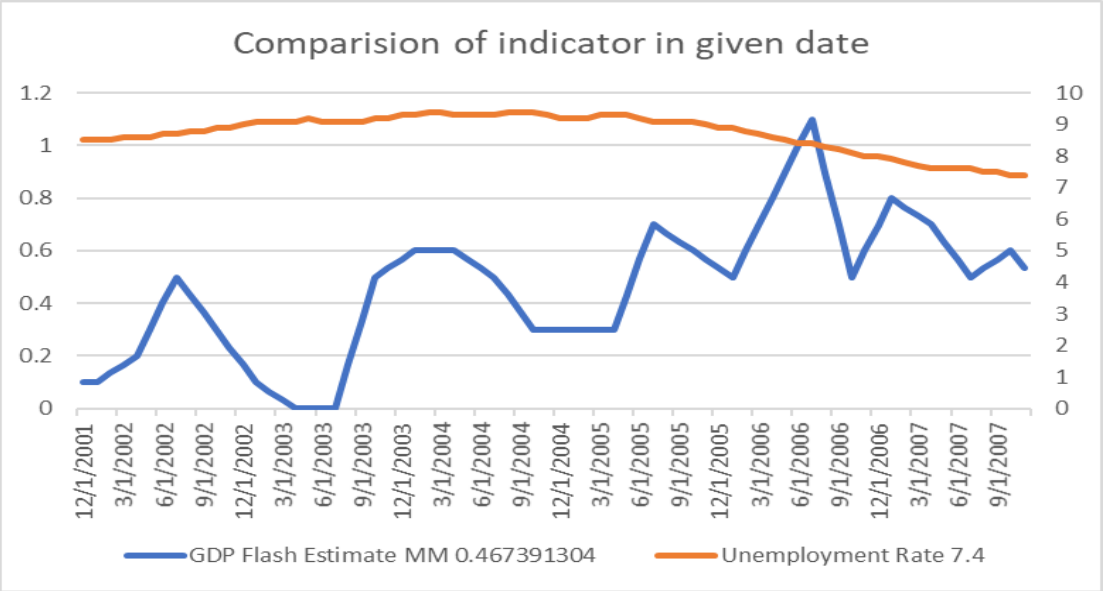
Post covid

ECB Analysis

ECB economy analysis differs from US and UK because its monetary policy is based on 'macroeconomic decisions' based on all member country's situations. While both US and UK economy was poorly affected by the great recession, Europe had worse impacts because the Eurozone economy was on the path of recovery when a

recession hit. Analyzing the indicators and monthly GDP data(monthly gdp obtained by interpolating quarterly GDP), we learned that the Eurozone economy started feeling the heat of recession of a typical business cycle in 2003, reaching a trough in 2005. We see that there one of the plateaus of the unemployment curve of the Eurozone occurred during this time.

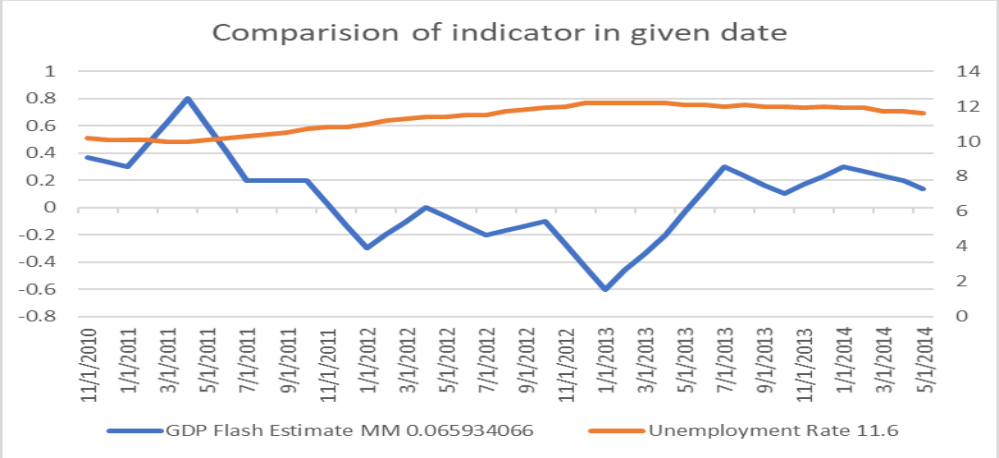
From 2006, the economy was recovering, and GDP growth was also on the positive side, but in 2007 recession hit, and the time when the Europe economy was considered to be on its way to the peak, it again felt a downfall.



economy recovery in 2006

EuroArea Debt crisis

When comparing all three economies, one prominent perception was felt from 2011-14. The US recovered well from the recession. The UK had a more prolonged recession but still managed to be on the positive side of GDP growth from 2011. Still, the Eurozone economy was hit by another recession. The unemployment rate in Eurozone started rising in 2011 and peaked in 2013. This was due to debt crises in EuroArea, where some countries' easing bond lending during the Global recession led to massive debts on Eurozone countries, which according to the ECB, led to 'credit gaps.' This was around two years of recession when Europe's economy was said to be affected the most. However, analyzing the 'harmonized CPI index,' which is the 'CPI value of all member countries harmonized, it was observed that also after the 2nd quarter of 2013, still though GDP growth was increasing, HCIP value continued falling until the end of 2014, which primarily indicated that there was the absence of unisons between economies of all member countries and debt crisis stayed longer for few countries, particularly southern countries.



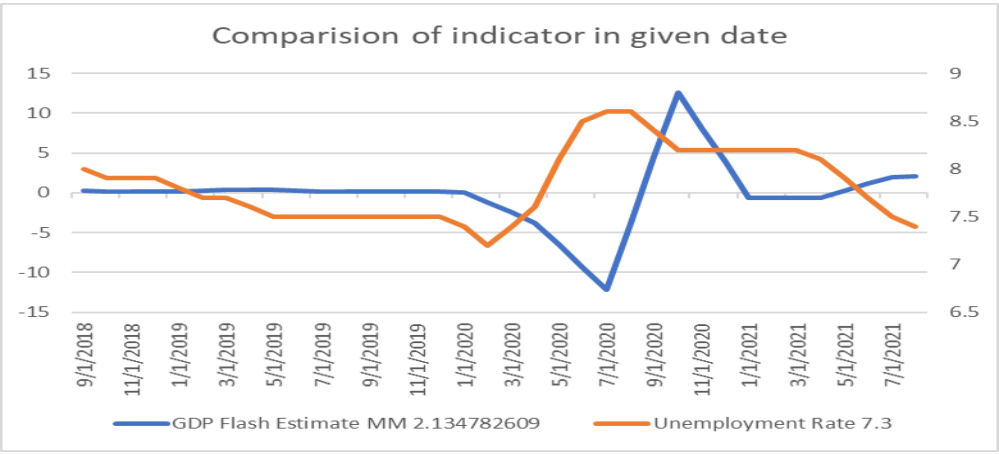
How unemployment rate peaked in 2013

Covid Period

During covid period, there was a lot of uncertainty, and the economic data was shoeing rambling figures with every advancement. Like FED, ECB also experienced sudden value changes in GDP growth from one quarter to another. In the second quarter of 2020, when the world was grappled by covid, the GDP growth of the ECB was -12.1%, the lowest ever. But in the next quarter, probably due to vaccines used and the easing of lockdowns, GDP growth was 12,7% on the positive side in just next quarter. But as soon as the second wave came, GDP again fell in the first quarter of 2021. However, the fall in GDP growth is not to be noticed because that massive growth was the compensation for the significant fall of the previous quarter, which is often said to be observed with GDP growth data during times of uncertainty.

Post Covid

It is to be noticed that the unemployment rate, which was evident to be increased when covid outbroke out, but still ECB recovered with the unemployment rate soon. It is to be observed that inflation in ECB rose with the steepest slope post covid and the HCIP value reached its peak in mid of 2022, due to which the deposit rate, which ECB always plans to keep low and which was -0.5% during covid, rose to its highest value of 2.25%. Also, market confidence saw a fall during high inflation.



See the increase in inflation and GDP growth fluatuating