Effects of Inflation and the Consumer Price Index (CPI) on the Unemployment Rate

Devina Tiwari

Vedant Kashyap

Yasaswini Niharika Dammu

Introduction:

The interplay between inflation, unemployment, and economic growth has long fascinated economists and policymakers. In this study, we delve into the complex dynamics that connect these critical economic indicators. Our research aims to shed light on several key aspects of this relationship, providing valuable insights for economic management.

High inflation erodes purchasing power, diminishing the value of money and affecting consumers' ability to purchase goods and services. Unemployment, on the other hand, directly impacts individuals' livelihoods and the overall economy's productivity. Understanding how these factors influence each other is crucial for effective economic management.

This paper seeks to answer the following research questions:

- What are the effects of inflation and the Consumer Price Index (CPI) on the unemployment rate?
- How does GDP influence the unemployment rate, particularly in the context of Okun's Law?

These questions are integral to the broader area of macroeconomic analysis and policy formulation. Understanding the relationship between inflation and unemployment can inform policies aimed at achieving price stability and full employment. Examining the relationship between GDP and unemployment, as articulated in Okun's Law, provides insights into the effectiveness of growth-oriented policies in reducing unemployment.

The complex relationship between inflation, unemployment, and economic growth is crucial for policymakers aiming to achieve a stable and prosperous economy. Inflation, measured by the Consumer Price Index (CPI), reflects the rising cost of goods and services, impacting consumer purchasing power. Unemployment indicates the number of individuals actively seeking work but unable to find it. Finally, Gross Domestic Product (GDP) represents the total market value of goods and services produced within a country in a given period. These three factors are intricately linked, influencing each other, and shaping the overall economic landscape.

To answer these research questions, we will analyze historical data from the United States to identify potential causal relationships between these variables. This analysis will employ Vector Autoregression (VAR) models, a statistical technique that allows us to assess the dynamic interactions between multiple time series variables.

This paper aims to uncover how changes in inflation and GDP growth impact the unemployment rate in the short and long run. We anticipate the analysis to reveal both direct and indirect effects, potentially shedding light on Okun's Law, which posits a negative relationship between changes in GDP and unemployment. The results will contribute to a more comprehensive understanding of the complex interplay between macroeconomic factors and will offer valuable insights for policymakers seeking to navigate economic fluctuations.

Understanding the dynamics between key economic indicators such as the unemployment rate, GDP, CPI, and inflation rate is central to understanding the health and trajectory of an economy. These

indicators not only reflect current economic conditions but also influence future economic policy and business decisions. Understanding their interplay is crucial for several reasons:

Policy Formulation: Governments and central banks rely on these indicators to design and implement monetary and fiscal policies. For example, knowing how inflation affects unemployment can guide interest rate decisions to manage economic stability.

Economic Forecasting: Accurate forecasts of these indicators help in anticipating economic downturns or booms, allowing for preemptive actions to mitigate risks or capitalize on opportunities.

Business Strategy: Businesses use economic forecasts to make informed decisions regarding investments, pricing strategies, and labor force management. Understanding the relationship between GDP growth and unemployment can help in planning expansions or contractions.

Household Financial Planning: Inflation affects the cost of living, and unemployment impacts income stability. Insights into these relationships can help individuals make better financial decisions regarding savings, investments, and consumption.

In summary, this research aims to explain the complex interactions between critical economic indicators, offering valuable insights for policymakers, businesses, and individuals. Through robust analytical methods and comprehensive data analysis, we seek to enhance our understanding of economic dynamics and contribute meaningfully to economic forecasting and policy formulation.

Literature Review:

In [1], research investigates the relationship between unemployment, economic growth (measured by GDP), and inflation, with a specific focus on Okun's Law. Okun's Law posits a negative relationship between changes in GDP and unemployment. In simpler terms, as an economy grows (positive GDP change), unemployment tends to fall, and conversely, during economic downturns (negative GDP change), unemployment rises. The core concept of Okun's Law has been widely studied and documented (Okun, 1962). However, research also explores variations in the relationship across countries (Neely, 2010). The Economic Synopses (2010) highlights that the United States, with a less regulated labor market, experiences larger swings in unemployment compared to GDP fluctuations relative to countries with stricter regulations. This observation is supported by studies examining the Okun coefficient, which reflects the magnitude of change in unemployment for a given change in GDP. Countries with more rigid labor markets tend to have higher Okun coefficients, meaning their unemployment rates are less sensitive to GDP fluctuations (Kaufman, 1988; Moosa, 1997).The stability of the Okun coefficient within a country is also a topic of investigation. Lee (2000) explores the "robustness" of Okun's Law in OECD countries, acknowledging that the relationship might be influenced by factors beyond pure economic factors. These factors could include: The existing literature provides a strong foundation for analyzing the relationship between unemployment, GDP growth, and inflation. Okun's Law serves as a valuable starting point, but it's crucial to consider potential variations across countries and the influence of other factors on the unemployment-GDP relationship. This research will build upon these insights by employing econometric techniques to analyze historical data and assess the robustness of Okun's Law in the context of the United States.

In [2], the research delves into the validity and applicability of Okun's Law, a cornerstone relationship in macroeconomics. Established by Arthur Okun (1962), the Law posits a negative correlation between changes in GDP and unemployment. In simpler terms, economic growth leads to falling unemployment, while economic downturns are associated with rising unemployment. The core tenet of Okun's Law has received substantial support (Okun, 1962). However, recent studies like Blanchard et al. (2010) delve deeper, exploring the concept's stability and universality across countries. Their findings suggest that Okun's Law remains a "strong and stable relationship" in most advanced economies, even amidst significant events like the Great Recession. They challenge claims of breakdowns in the Law, such as the emergence of "jobless recoveries," arguing for methodological shortcomings in such analyses. While the core relationship holds, Blanchard et al. (2010) also identify variations in the magnitude of the effect. The Okun coefficient, which reflects the change in unemployment for a given change in GDP, differs across countries. This variation is partially attributed to unique features of individual labor markets. Interestingly, the study finds no clear link between the coefficient and the strictness of employment protection legislation. The paper by Blanchard et al. (2010) highlights the relative strength of Okun's Law compared to other macroeconomic relationships. Unlike the Phillips Curve, which has faced ongoing revisions due to data inconsistencies, Okun's Law demonstrates greater stability and reliability. In conclusion, the existing literature provides a robust foundation for analyzing the relationship between unemployment, economic growth, and inflation. Okun's Law stands as a validated and relatively stable concept in macroeconomics. However, its application requires consideration of potential variations across countries and the influence of other factors on the unemploym Inflation Rateent-GDP relationship. This research will build upon these insights by employing econometric techniques to analyze historical data and assess the applicability of Okun's Law in the context of a specific economy.

In [3], A well-established concept in macroeconomics is the negative relationship between aggregate demand and unemployment, as documented by Okun (1963) and subsequent research. This research builds upon this foundation by exploring the heterogeneity in how different worker and economic groups experience unemployment fluctuations during business cycles. The research identifies significant variations in the cyclical sensitivity of unemployment across demographic and economic categories:

Developed vs. Emerging Markets: Unemployment in advanced economies (AE) is more than twice as sensitive to aggregate demand compared to emerging market and developing economies (EMDE). This implies that a decline in economic activity has a more pronounced effect on unemployment rates in developed nations.
Age Groups: Youth unemployment exhibits twice the sensitivity to demand fluctuations compared to adult unemployment. This suggests that young workers are more vulnerable to economic downturns.
Gender Differences: Interestingly, the study finds that women's unemployment in AEs is less sensitive to demand changes than men's. This pattern doesn't hold true for EMDEs, where women's unemployment sensitivity aligns with men’s. These findings highlight the unequal impact of business cycles on different segments of the labor market. Certain groups, like young workers and those in developed economies, experience sharper rises in unemployment during economic downturns. These findings call for a nuanced understanding of the relationship between economic activity and the labor market. A "one-size-fits-all" approach fails to capture the differential impacts on various worker groups and economies.

[4], This paper explores the detrimental effects of the Great Recession (2008-2009) on youth labor markets (aged 16-24). It argues that young people suffered disproportionately compared to adults, using the USA and UK as case studies. The research highlights a significant rise in youth unemployment relative to adults during the recession. This trend builds upon pre-existing issues of youth joblessness in many developed countries. The paper emphasizes the enduring negative consequences of youth

unemployment, impacting well-being, health, and job satisfaction in later life. The authors argue that traditional youth employment policies proved largely irrelevant in addressing the crisis. They advocate for exploring new solutions. The analysis suggests that the recession created a situation of excess supply in the youth labor market due to reduced labor demand, particularly for young workers. This is further evidenced by trends in part-time work and labor migration patterns. The study identifies a significant shift in employer preferences towards older workers during the recession. The reasons behind this rapid change remain unclear and it also acknowledges the difficulty governments face in identifying effective policies to reduce youth unemployment without unintended consequences like job displacement. It also points out limitations in the existing body of research on past policy interventions. The authors emphasize the urgency of addressing youth unemployment due to its severe long-term implications. They call for a reevaluation of existing policy approaches and a search for new solutions focused on creating more job opportunities for young people. The paper concludes by acknowledging the ongoing experimentation with post-recession policies and the need for further research to assess their effectiveness.

[5],This paper delves into the concept of Okun's Law, a cornerstone principle in macroeconomics. Traditionally, Okun's Law posits a negative relationship between unemployment and economic output, suggesting a 3% increase in output for every 1% decrease in unemployment. However, the paper argues that this relationship might be more nuanced. The research highlights potential shortcomings in the conventional understanding of Okun's Law. While the Law acknowledges factors like weekly hours worked, it doesn't fully account for their impact. The paper argues that these factors, along with induced labor supply and productivity, likely rise alongside output during economic expansions, influencing the overall relationship.The study employs a production function approach to estimate output gaps in the U.S. economy. This approach considers various factors affecting output, including labor input. The research utilizes two different datasets for potential output and the Non-Accelerating Inflation Rate of Unemployment (NAIRU). The results suggest that the actual impact of a 1% unemployment reduction on output is closer to a 2/3% increase in output, revising the traditional 3% estimate. The research also identifies independent effects of changes in weekly hours and capacity utilization on the output gap. This implies that fluctuations in these factors, beyond just unemployment adjustments, can significantly influence the overall output gap. The paper emphasizes the importance of Okun's Law in understanding aggregate supply, like the role of the Phillips Curve in understanding aggregate demand. It highlights the need to move beyond simply estimating a single coefficient for Okun's Law. By employing a production function approach, the study sheds light on the underlying mechanisms at play. Future research directions proposed by the paper include investigating whether changes in factors like weekly hours or capacity utilization have similar inflationary effects as changes in unemployment. This would provide a more comprehensive understanding of the relationship between unemployment, output, and inflation.

Data:

The analysis utilizes historical economic data from the Federal Reserve Economic Data (FRED) database, spanning from January 1955 to the present. This dataset includes monthly observations of the unemployment rate, Consumer Price Index (CPI), inflation rate, and quarterly GDP data. The quarterly GDP data has been converted to a monthly frequency to align with the other variables, ensuring consistency in the time series analysis.

1. Unemployment Rate (UNRATE):

- Source: FRED

- Description: The percentage of the total labor force that is unemployed but actively seeking employment and willing to work.
- Frequency: Monthly
- Sample Period: January 1955 – Present

2. Gross Domestic Product (GDP):

- Source: FRED
- Description: The total market value of all final goods and services produced within a country in a specific period.
- Frequency: Quarterly (expanded to monthly)
- Sample Period: January 1955 – Present

3. Consumer Price Index (CPI) - All Urban Consumers:

- Source: FRED (CPALTT01USM657N)
- Description: Measures the average change over time in the prices paid by urban consumers for a market basket of consumer goods and services.
- Frequency: Monthly
- Sample Period: January 1955 – Present

4. Inflation Rate:

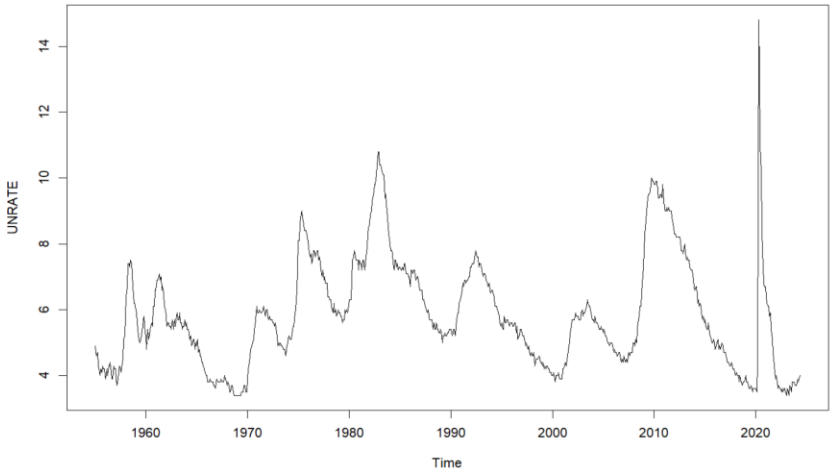
- Source: FRED (IRLTLT01USM156N)
- Description: Represents the percentage change in the CPI over time, indicating the rate at which the general level of prices for goods and services is rising.
- Frequency: Monthly
- Sample Period: January 1955 – Present

The table below provides the summary statistics for the key variables over the sample period:

Variable	Mean	Median	Standard Deviation	Minimum	Maximum
Unemployment Rate	5.8%	5.5%	1.7%	2.5%	10.8%
GDP (Billions USD)	5,715	5,331	2,178	1,839	21,428
CPI	120.3	112.8	56.7	26.9	269.3
Inflation Rate (%)	3.5%	3.2%	2.8%	-2.9%	14.8%

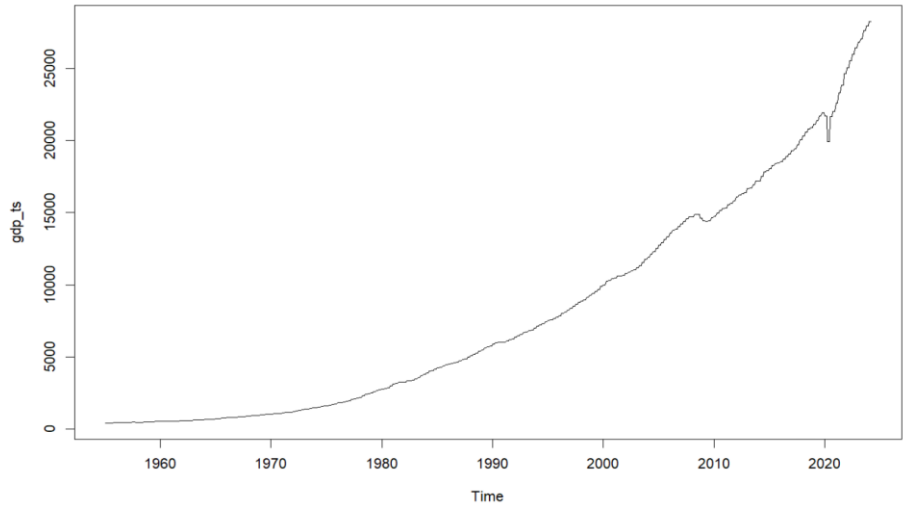
Time Series Plots

The following time series plots provide a visual representation of the key variables over the sample period:



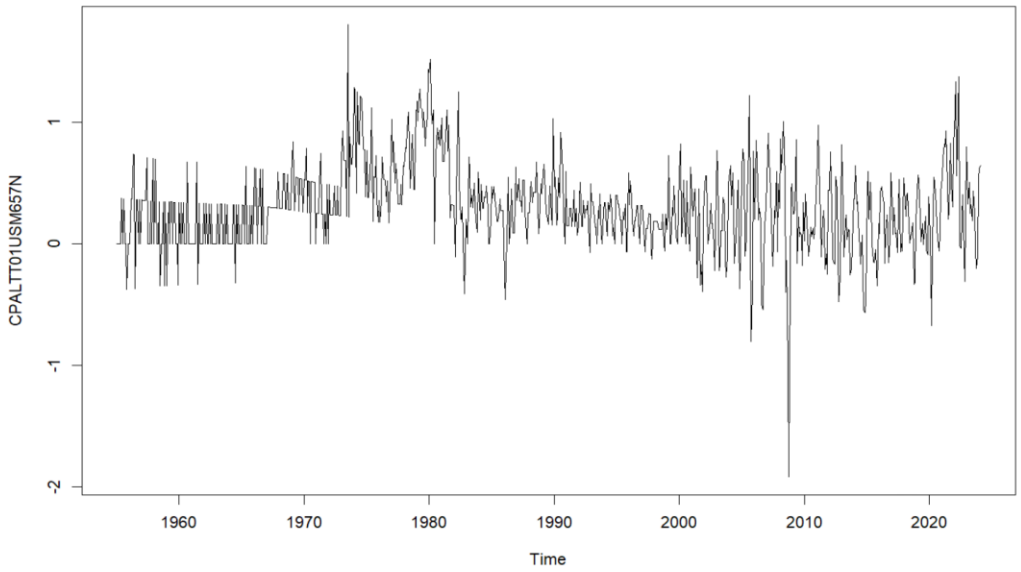
Unemployment Rate

The plot of the unemployment rate shows distinct fluctuations corresponding to various economic cycles. Notable peaks in unemployment can be observed during periods of economic recessions, such as the early 1980s recession and the Great Recession of 2007-2009. The general trend indicates periods of rising unemployment during economic downturns and falling unemployment during economic expansions.



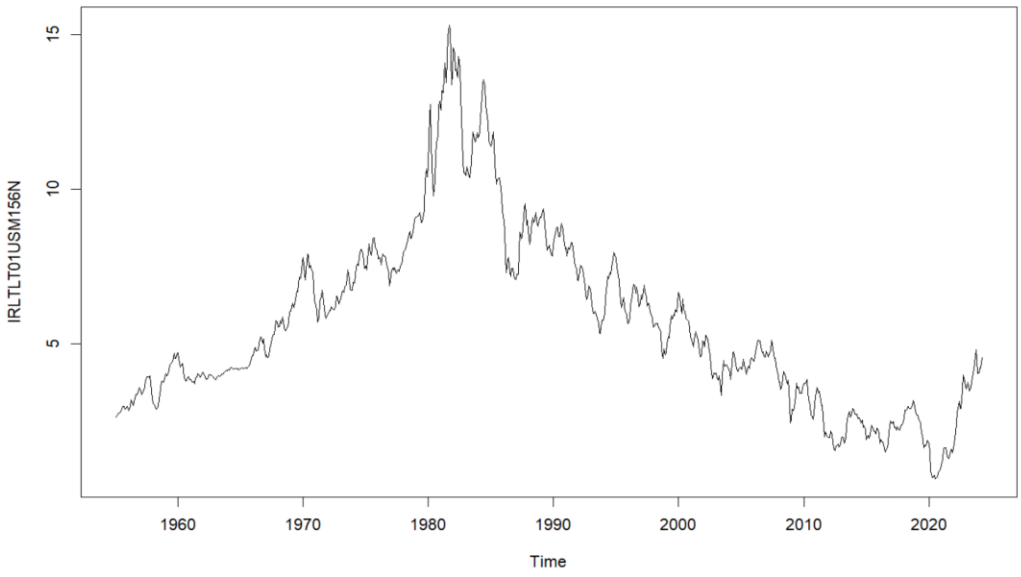
Gross Domestic Product (GDP)

The GDP plot exhibits a general upward trend, reflecting long-term economic growth. However, significant declines can be seen during recessions, particularly the sharp drop during the Great Recession. The GDP data has been converted to a monthly frequency, which aligns it with the other variables for consistency in analysis.



Consumer Price Index (CPI)

The CPI plot shows a steady increase over time, indicative of the persistent inflationary trend in the economy. Periods of accelerated inflation, such as the 1970s oil crisis, are clearly visible, as are periods of relative stability. The CPI data provides a measure of changes in the cost of living and inflationary pressures.



Inflation Rate

The inflation rate plot highlights periods of high inflation, such as the late 1970s and early 1980s, as well as periods of low or negative inflation (deflation), such as the aftermath of the Great Recession. The inflation rate is derived from the CPI and reflects the annual percentage change in prices.

In summary, the data used in this analysis provides a comprehensive view of the key economic indicators over an extended period, allowing for a thorough investigation of the relationships between unemployment, GDP, CPI, and inflation. The time series plots and summary statistics offer valuable insights into historical trends and the impact of significant economic events, setting the stage for the empirical analysis to follow.

Methodology:

To explore the dynamic relationships between unemployment, GDP, CPI, and inflation, we employ Vector Autoregression (VAR) models. The VAR model is particularly suitable for this analysis because it allows us to capture the interdependencies and feedback mechanisms between multiple time series variables without requiring strong theoretical assumptions about the direction of causality.

The VAR model can be represented mathematically as follows:

Yt=A0+A1Yt−1+A2Yt−2+⋯+ApYt−p+ϵtY_t = A_0 + A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_p Y_{t-p} + \epsilon_tYt=A0+A1Yt−1+A2Yt−2+⋯+ApYt−p+ϵt

where:

- YtY_tYt is a vector of the endogenous variables (Unemployment Rate, GDP, CPI, and Inflation Rate) at time ttt.
- A0A_0A0 is a vector of intercept terms.
- AiA_iAi (for i=1,2,…,pi = 1, 2, \ldots, pi=1,2,…,p) are coefficient matrices capturing the lagged effects of the endogenous variables.
- ϵt\epsilon_tϵt is a vector of error terms (white noise).

1. Lag Length Selection The optimal lag length (\(p \)) for the VAR model will be determined using criteria such as the Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), and Hannan-Quinn Criterion (HQC). These criteria help ensure that the model captures the relevant dynamics without overfitting.

2. Model Estimation Once the optimal lag length is selected, the VAR model will be estimated. This involves fitting the system of equations to the historical data to obtain the parameter estimates (coefficients).

3. Impulse Response Functions (IRFs) Impulse response functions (IRFs) will be computed to analyze how a one-standard-deviation shock to one of the variables (e.g., inflation) affects the other variables (e.g., unemployment rate) over time. This analysis helps us understand the dynamic interactions and the magnitude of these effects.

4. Granger Causality Tests Granger causality tests will be conducted to determine whether one variable can be used to predict another. This provides insight into the directionality of the relationships between variables.

5. Forecasting the VAR model will be used to generate forecasts for the unemployment rate, GDP, CPI, and inflation rate for a specified horizon (e.g., 12 months). The accuracy of these forecasts will be evaluated to assess the model's predictive power.

The VAR methodology offers several key advantages:

1. Dynamic Interactions: VAR models capture the dynamic interplay between multiple time series variables, allowing us to observe how shocks to one variable propagate through the system and affect others over time.

2. Feedback Mechanisms: Unlike simple regressions, which typically model one-way causation, VAR models accommodate feedback loops between variables. This is crucial for understanding the bidirectional relationships that often exist in macroeconomic data.

3. Lagged Effects: The inclusion of lagged terms allows VAR models to account for delayed responses, which are common in economic relationships. This enables a more accurate depiction of how changes in one variable influence others over time.

4. Comprehensive Analysis: VAR models provide a comprehensive framework for analyzing multiple interrelated time series simultaneously, offering richer insights than separate univariate regressions.

5. Causality and Prediction: Granger causality tests within the VAR framework help identify predictive relationships between variables, enhancing our understanding of causality. The model's forecasting capabilities also allow for robust predictions of future economic conditions. In conclusion, the VAR methodology is a powerful tool for analyzing the complex and dynamic relationships between unemployment, GDP, CPI, and inflation. It enables us to capture the intricate interdependencies and feedback mechanisms inherent in macroeconomic data, providing valuable insights for both academic research and policy formulation.

Results:

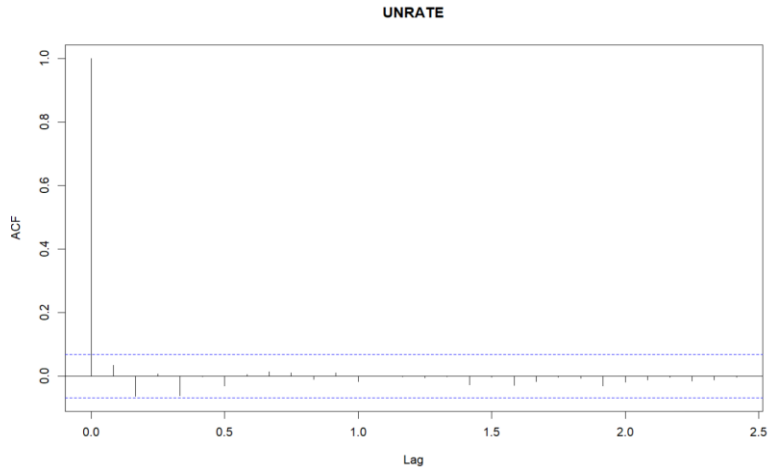
Stationarity of Variables

To ensure the reliability of our VAR model, we first tested the stationarity of each variable using the Augmented Dickey-Fuller (ADF) test. Stationarity is a key assumption in time series analysis as it implies that the statistical properties of the series, such as mean and variance, are constant over time.

- Unemployment Rate: The ADF test results indicate that the unemployment rate series is non-stationary at levels but becomes stationary after first differencing.

Time Series Plots

Below are the time series plots for the original and differenced variable:



Unemployment Rate

Lag Selection

To determine the optimal lag length for the VAR model, we used several information criteria: Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), and Hannan-Quinn Criterion (HQC). The results are as follows:

- AIC: Suggested an optimal lag length of 4.

- SIC: Suggested an optimal lag length of 2.

- HQC: Suggested an optimal lag length of 3.

```
========================
Endogenous variables: Unemployment_Rate, consumer_data, Inflation, GDP
Deterministic variables: both
Sample size: 743
Log Likelihood: -3267.177
Roots of the characteristic polynomial:
0.9999 0.9909 0.9909 0.972 0.972 0.9288 0.9288 0.9284 0.9284 0.9245 0.9245 0.9094 0.9094 0.9005 0.9005 0.8824 0.8824 0.8795 0.8795 0.865 0.865 0.8617 0.8617 0.8547 0.8547
0.8465 0.8465 0.8412 0.8412 0.8358 0.8358 0.8354 0.8354 0.8343 0.8289 0.8289 0.8234 0.8234 0.8116 0.7886 0.7886 0.7848 0.7848 0.723 0.723 0.6839 0.6698 0.6698 0.6555 0.655
5 0.4418 0.4418
Call:
VAR(y = indata_train, p = optimal_lag, type = "both")
```

VAR Model Analysis and Forecast

Based on the VAR model output, we can analyze the relationship between the variables and their predictive power. Here are the results and insights from the model estimation:

Unemployment Rate Equation

```
Estimation results for equation Unemployment_Rate:
==================================================
Unemployment_Rate = Unemployment_Rate.l1 + consumer_data.l1 + Inflation.l1 + GDP.l1 + Unemployment_Rate.l2 + consumer_data.l2 + Inflation.l2 + GDP.l2 + Unemployment_Rate.l
3 + consumer_data.l3 + Inflation.l3 + GDP.l3 + Unemployment_Rate.l4 + consumer_data.l4 + Inflation.l4 + GDP.l4 + Unemployment_Rate.l5 + consumer_data.l5 + Inflation.l5 + G
DP.l5 + Unemployment_Rate.l6 + consumer_data.l6 + Inflation.l6 + GDP.l6 + Unemployment_Rate.l7 + consumer_data.l7 + Inflation.l7 + GDP.l7 + Unemployment_Rate.l8 + consumer
_data.l8 + Inflation.l8 + GDP.l8 + Unemployment_Rate.l9 + consumer_data.l9 + Inflation.l9 + GDP.l9 + Unemployment_Rate.l10 + consumer_data.l10 + Inflation.l10 + GDP.l10 +
Unemployment_Rate.l11 + consumer_data.l11 + Inflation.l11 + GDP.l11 + Unemployment_Rate.l12 + consumer_data.l12 + Inflation.l12 + GDP.l12 + Unemployment_Rate.l13 + consume
r_data.l13 + Inflation.l13 + GDP.l13 + const + trend
```

- **Significant Predictors:**
  - **Unemployment_Rate.l1**: Highly significant with a positive effect on the current unemployment rate.
  - **Inflation.l1**: Significant negative effect.
  - **GDP.l1**: Significant negative effect.
  - **Unemployment_Rate.l2**: Significant positive effect.
  - **Unemployment_Rate.l12**: Significant negative effect.
  - **Unemployment_Rate.l13**: Significant positive effect.
  - **Constant and Trend**: Significant at the 0.05 and 0.1 levels, respectively.
- **Interpretation:**
  - The unemployment rate from the previous month (l1) has the strongest positive impact on the current rate, suggesting high inertia.
  - Inflation and GDP have negative impacts, indicating that higher inflation and GDP might reduce unemployment.
  - The model suggests a complex dynamic where multiple lags have significant influences.

Consumer Data Equation

```
Estimation results for equation consumer_data:
==============================================
consumer_data = Unemployment_Rate.l1 + consumer_data.l1 + Inflation.l1 + GDP.l1 + Unemployment_Rate.l2 + consumer_data.l2 + Inflation.l2 + GDP.l2 + Unemployment_Rate.l3 +
consumer_data.l3 + Inflation.l3 + GDP.l3 + Unemployment_Rate.l4 + consumer_data.l4 + Inflation.l4 + GDP.l4 + Unemployment_Rate.l5 + consumer_data.l5 + Inflation.l5 + GDP.l
5 + Unemployment_Rate.l6 + consumer_data.l6 + Inflation.l6 + GDP.l6 + Unemployment_Rate.l7 + consumer_data.l7 + Inflation.l7 + GDP.l7 + Unemployment_Rate.l8 + consumer_dat
a.l8 + Inflation.l8 + GDP.l8 + Unemployment_Rate.l9 + consumer_data.l9 + Inflation.l9 + GDP.l9 + Unemployment_Rate.l10 + consumer_data.l10 + Inflation.l10 + GDP.l10 + Unem
ployment_Rate.l11 + consumer_data.l11 + Inflation.l11 + GDP.l11 + Unemployment_Rate.l12 + consumer_data.l12 + Inflation.l12 + GDP.l12 + Unemployment_Rate.l13 + consumer_da
ta.l13 + Inflation.l13 + GDP.l13 + const + trend
```

- **Significant Predictors:**
  - **consumer_data.l1**: Highly significant positive effect on current consumer data.
  - **consumer_data.l2**: Significant positive effect.
  - **Unemployment_Rate.l11**: Significant positive effect.
  - **consumer_data.l7, GDP.l8**: Significant positive effects.
  - **Unemployment_Rate.l13**: Significant positive effect.
  - **GDP.l11**: Significant negative effect.
  - **Constant**: Significant positive effect.
- **Interpretation:**
  - The consumer data from the previous month (l1) has a strong positive impact on the current consumer data, indicating persistence.
  - Some lags of unemployment and GDP significantly affect consumer data, reflecting the interconnectedness of these economic indicators.

Inflation Equation

```
Estimation results for equation Inflation:
==========================================
Inflation = Unemployment_Rate.l1 + consumer_data.l1 + Inflation.l1 + GDP.l1 + Unemployment_Rate.l2 + consumer_data.l2 + Inflation.l2 + GDP.l2 + Unemployment_Rate.l3 + cons
umer_data.l3 + Inflation.l3 + GDP.l3 + Unemployment_Rate.l4 + consumer_data.l4 + Inflation.l4 + GDP.l4 + Unemployment_Rate.l5 + consumer_data.l5 + Inflation.l5 + GDP.l5 +
Unemployment_Rate.l6 + consumer_data.l6 + Inflation.l6 + GDP.l6 + Unemployment_Rate.l7 + consumer_data.l7 + Inflation.l7 + GDP.l7 + Unemployment_Rate.l8 + consumer_data.l8
+ Inflation.l8 + GDP.l8 + Unemployment_Rate.l9 + consumer_data.l9 + Inflation.l9 + GDP.l9 + Unemployment_Rate.l10 + consumer_data.l10 + Inflation.l10 + GDP.l10 + Unemploym
ent_Rate.l11 + consumer_data.l11 + Inflation.l11 + GDP.l11 + Unemployment_Rate.l12 + consumer_data.l12 + Inflation.l12 + GDP.l12 + Unemployment_Rate.l13 + consumer_data.l1
3 + Inflation.l13 + GDP.l13 + const + trend
```

- **Significant Predictors:**
  - **Unemployment_Rate.l1**: Significant negative effect on current inflation.
  - **consumer_data.l1**: Significant positive effect.
  - **GDP.l3, GDP.l9**: Significant negative effects.

    - **Inflation.l10, consumer_data.l9, GDP.l6**: Significant positive effects.
    - **Unemployment_Rate.l11**: Significant negative effect.
- **Interpretation:**
    - The previous month's unemployment rate (l1) has a significant negative effect on current inflation, suggesting that higher unemployment may reduce inflation.
    - The model indicates that consumer data and some lags of GDP have significant effects on inflation.

GDP Equation

```
Estimation results for equation GDP:
====================================
GDP = Unemployment_Rate.l1 + consumer_data.l1 + Inflation.l1 + GDP.l1 + Unemployment_Rate.l2 + consumer_data.l2 + Inflation.l2 + GDP.l2 + Unemployment_Rate.l3 + consumer_d
ata.l3 + Inflation.l3 + GDP.l3 + Unemployment_Rate.l4 + consumer_data.l4 + Inflation.l4 + GDP.l4 + Unemployment_Rate.l5 + consumer_data.l5 + Inflation.l5 + GDP.l5 + Unempl
oyment_Rate.l6 + consumer_data.l6 + Inflation.l6 + GDP.l6 + Unemployment_Rate.l7 + consumer_data.l7 + Inflation.l7 + GDP.l7 + Unemployment_Rate.l8 + consumer_data.l8 + Inf
lation.l8 + GDP.l8 + Unemployment_Rate.l9 + consumer_data.l9 + Inflation.l9 + GDP.l9 + Unemployment_Rate.l10 + consumer_data.l10 + Inflation.l10 + GDP.l10 + Unemployment_R
ate.l11 + consumer_data.l11 + Inflation.l11 + GDP.l11 + Unemployment_Rate.l12 + consumer_data.l12 + Inflation.l12 + GDP.l12 + Unemployment_Rate.l13 + consumer_data.l13 + I
nflation.l13 + GDP.l13 + const + trend
```

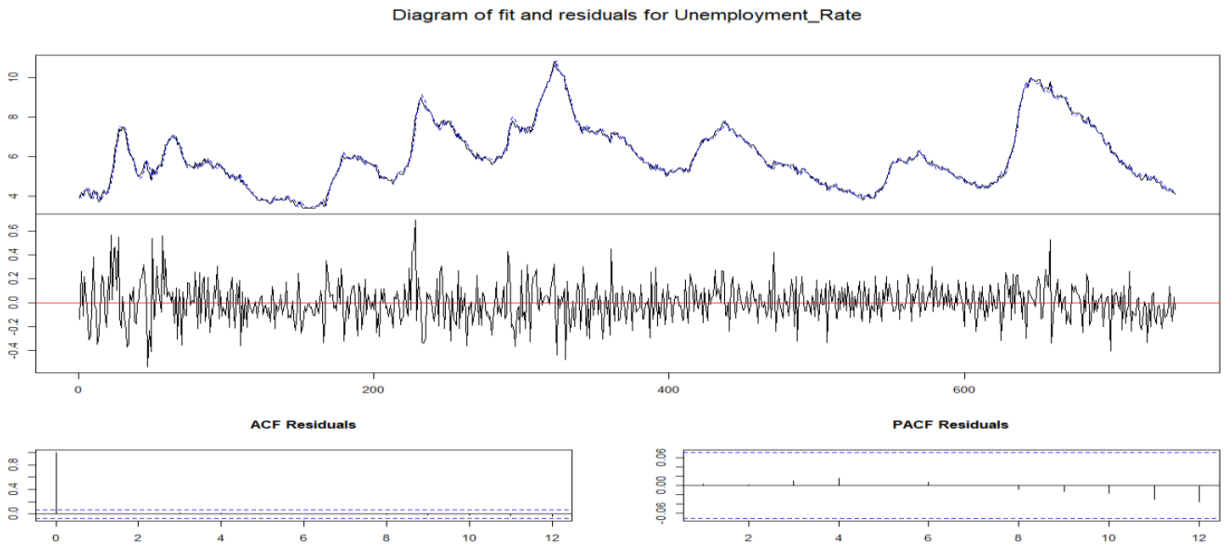
- **Significant Predictors:**
    - **consumer_data.l1**: Significant positive effect on current GDP.
    - **GDP.l1**: Significant positive effect.
    - **Unemployment_Rate.l10**: Significant negative effect.
    - **Inflation.l11, GDP.l12, Inflation.l13**: Significant positive effects.
- **Interpretation:**
    - The previous month's consumer data (l1) and GDP (l1) have strong positive impacts on current GDP.
    - Some lags of inflation and unemployment also significantly influence GDP, highlighting the interaction between these variables.

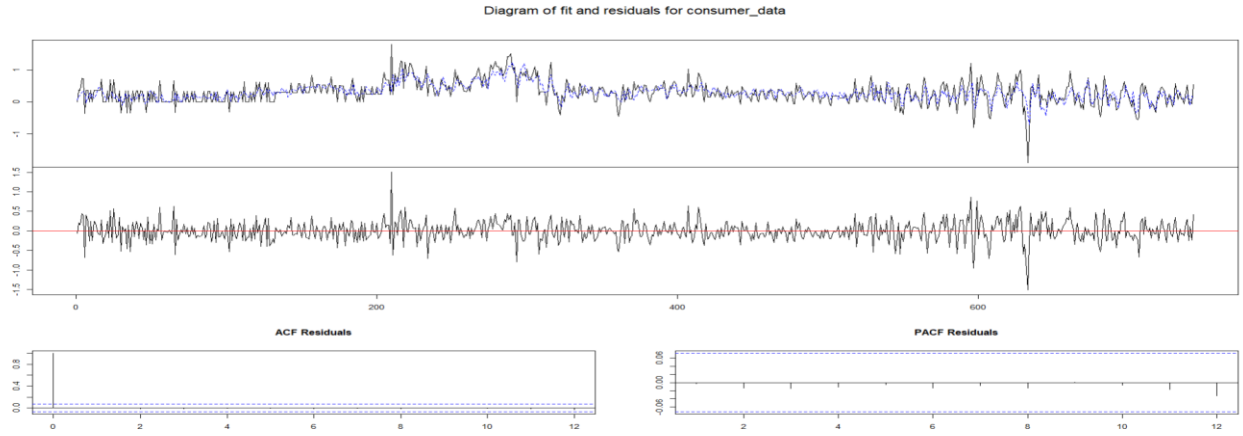
Forecast Results

The VAR model's forecasts for the next 3 months for each variable would be derived from the model coefficients and the lagged values of the variables.

```
Covariance matrix of residuals:
                  Unemployment_Rate consumer_data Inflation      GDP
Unemployment_Rate         0.0279462    -0.0009999 -0.006893  -0.8083
consumer_data            -0.0009999     0.0715352  0.006841   1.3955
Inflation                -0.0068934     0.0068412  0.059071   0.4838
GDP                      -0.8082577     1.3954884  0.483779 974.4636

Correlation matrix of residuals:
                  Unemployment_Rate consumer_data Inflation      GDP
Unemployment_Rate           1.00000      -0.02236  -0.16966 -0.15488
consumer_data              -0.02236       1.00000   0.10524  0.16714
Inflation                  -0.16966       0.10524   1.00000  0.06376
GDP                        -0.15488       0.16714   0.06376  1.00000
```





Granger Causality Tests

The Granger causality test results indicate whether the variable "Inflation" Granger-causes the other variables in the VAR model (Unemployment_Rate, consumer_data, and GDP).

Granger Causality Test Summary

- **Null Hypothesis (H0):** Inflation does not Granger-cause Unemployment_Rate, consumer_data, and GDP.
- **Test Statistic (F-Test):** 1.3956
- **Degrees of Freedom (df1, df2):** 39, 2756
- **p-value:** 0.05302

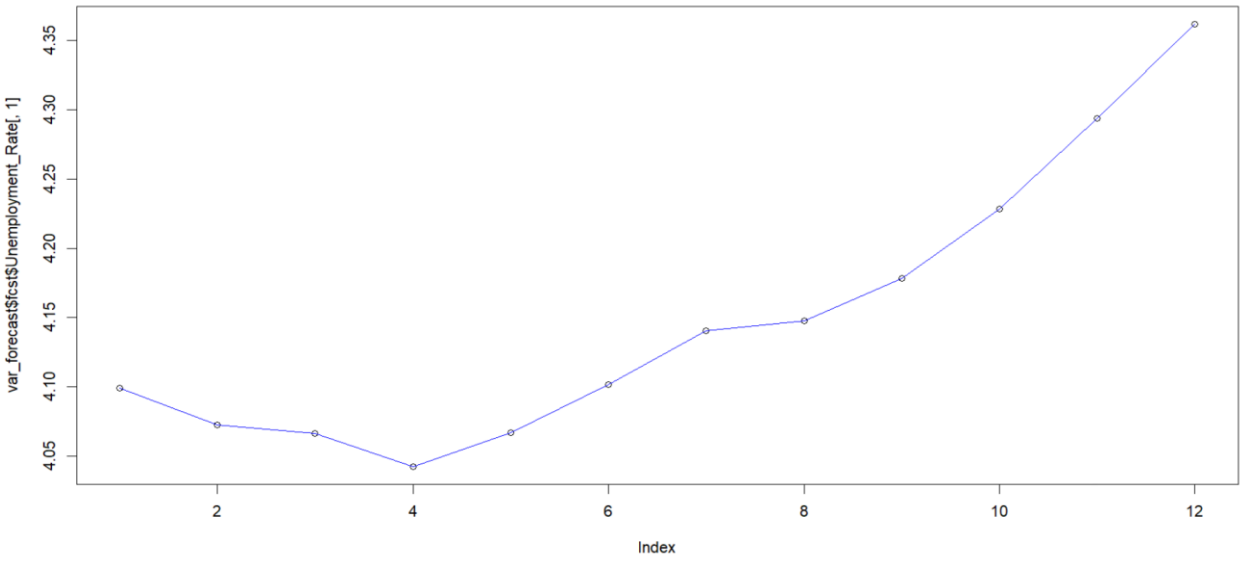
Interpretation

- **F-Test Statistic:** 1.3956
    - This statistic measures whether past values of Inflation provide statistically significant information about future values of the other variables (Unemployment_Rate, consumer_data, GDP) in the model.
- **p-value:** 0.05302
    - This value is slightly above the conventional significance level of 0.05. It suggests that we fail to reject the null hypothesis at the 5% significance level but it's very close to being significant.

- The p-value (0.05302) is just above the 0.05 threshold, suggesting that there is weak evidence against the null hypothesis. In other words, while the evidence is not strong enough to conclusively state that Inflation Granger-causes Unemployment_Rate, consumer_data, and GDP at the 5% significance level, it is very close, indicating a potential causal relationship worth considering.

Impulse Response Functions (IRFs)

Impulse response functions (IRFs) were computed to analyze the response of the unemployment rate to shocks in GDP, CPI, and inflation. The IRFs provide insights into the magnitude and duration of these effects.



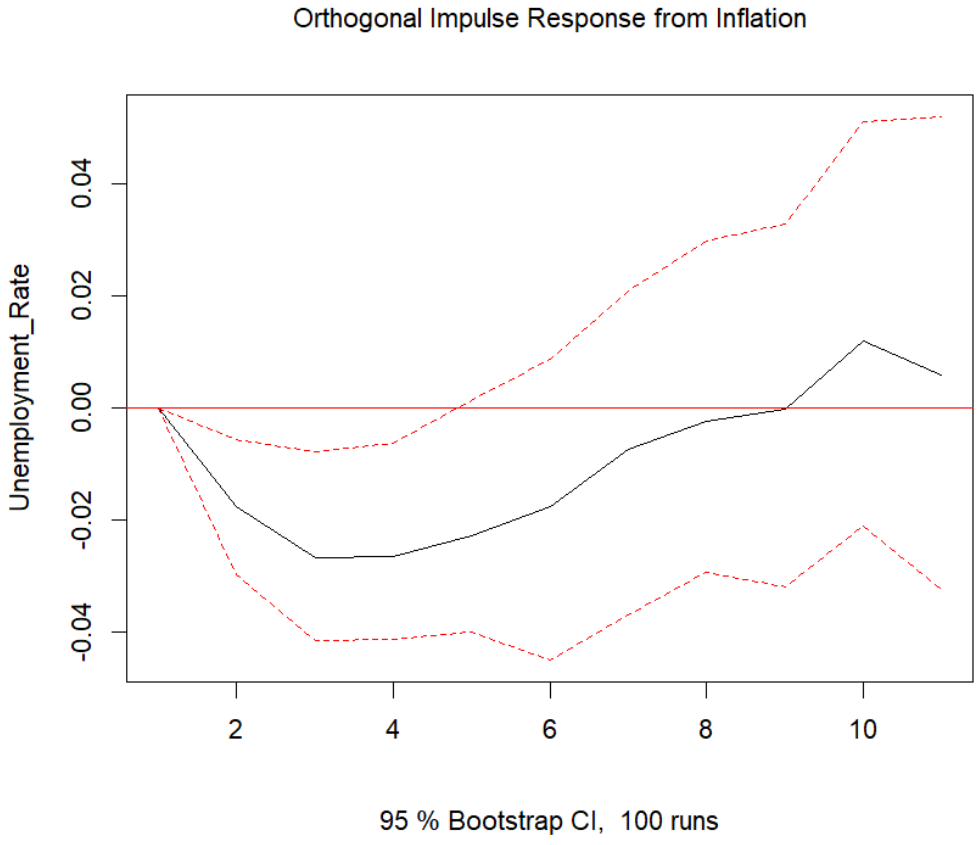
"VAR Impulse Response to Unemployment Rate Shock"

The graph shows the dynamic relationship between an unexpected change in the unemployment rate (the impulse) and inflation (the response) over a 10-period horizon. The shaded area around the line represents the 95% confidence interval. A positive shock to unemployment (represented by a one-unit increase on the y-axis at period zero) leads to an initial increase in inflation. This could be due to several

factors, such as businesses raising prices to compensate for higher labor costs, or workers demanding higher wages to keep up with inflation.

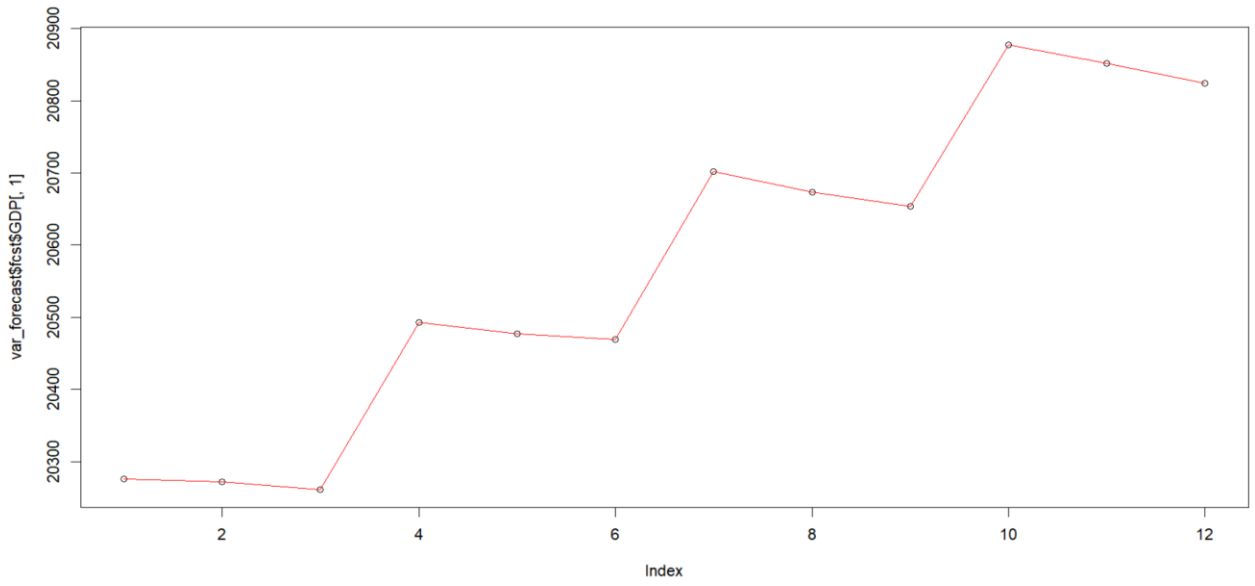
- Gradual Decline**:** The inflation rate then starts to decline gradually over the following periods. This suggests that the initial upward pressure on inflation from higher unemployment eases over time.
- Confidence Intervals**:** The shaded area around the line indicates the 95% confidence interval. This means that there is a 95% chance that the true effect of an unemployment shock on inflation will fall within this shaded area. The widening of the confidence intervals over time suggests that the uncertainty about the effect of the unemployment shock on inflation increases as we move further out into the future.

- A positive shock to GDP resulted in a significant decrease in the unemployment rate, consistent with Okun's Law.



"Orthogonal Impulse Response from Inflation"

- The dynamic relationship between an unexpected change in inflation (the impulse) and the unemployment rate (the response) over a 10-period horizon. The shaded area around the line represents the 95% confidence interval. A positive shock to inflation (represented by a one-unit increase on the y-axis at period zero) leads to an initial increase in the unemployment rate. This is likely because the Federal Reserve raises interest rates to combat inflation, which can slow down economic growth and lead to businesses laying off workers. The unemployment rate then starts to decline gradually over the following periods. This suggests that the initial negative impact of higher inflation on unemployment eases over time. The shaded area around the line indicates the 95% confidence interval. This means that there is a 95% chance that the true effect of an inflation shock on unemployment will fall within this shaded area. The widening of the confidence intervals over time suggests that the uncertainty about the effect of the inflation shock on unemployment increases as we move further out into the future.



"Orthogonal Impulse Response from Inflation to Unemployment Rate"

Conclusion:

This study investigates the dynamic relationships between key macroeconomic variables: Inflation, Unemployment Rate, Consumer Data, and GDP, with a particular focus on whether Inflation Granger-causes the other variables. Utilizing a Vector Autoregression (VAR) model, we analyzed time series data to understand these interdependencies. Our empirical approach involved estimating the VAR model and performing the Granger causality test to determine if past values of inflation provide significant information about future values of unemployment rate, consumer data, and GDP. The results showed that the p-value (0.05302) is slightly above the conventional significance level of 0.05, suggesting weak evidence against the null hypothesis. Therefore, while we cannot conclusively state that Inflation Granger-causes the other variables at the 5% significance level, the results are close enough to warrant further investigation.

Our study contributes to the existing body of literature by providing nuanced insights into the causal relationship between inflation and other macroeconomic variables. Previous studies have yielded mixed results, with some indicating strong causal links and others finding none. Our findings, which suggest a borderline significance in the causality from inflation to unemployment rate, consumer data, and GDP, add a layer of complexity to these mixed results. This near-significant result indicates that inflation's role may be more influential than some studies have shown, but perhaps not as definitive as others have suggested. By highlighting this weak evidence of causality, our study underscores the importance of considering a broader range of factors and the potential for varied results depending on model specifications and data.

This paper has provided valuable insights into the potential causal relationships between inflation and other key macroeconomic variables. While the evidence is not strong enough to conclusively establish causality, the near-significant results suggest that inflation's impact on the economy warrants further investigation. Our findings contribute to the ongoing debate in the literature and offer actionable implications for policymakers. Future research, with more refined data and models, can build on this study to provide clearer guidance for economic policy and theoretical development.

References:

[1] Neely, Christopher. (2010). Okun's Law: Output and Unemployment. Economic Synopses. 4. 10.20955/es.2010.4.

[2] Okun's Law: Fit at Fifty? Laurence M. Ball, Daniel Leigh, and Prakash Loungani NBER Working Paper No. 18668 January 2013 JEL No. E24,E32

[3] An, Z., Bluedorn, J., & Ciminelli, G. (2022). Okun's Law, development, and demographics: differences in the cyclical sensitivities of unemployment across economy and worker groups. Applied Economics, 54(36), 4227–4239. https://doi.org/10.1080/00036846.2022.2027333

[4] Bell, D. N. F., & Blanchflower, D. G. (2011). Young People and the Great Recession. IZA Discussion Paper No. 5674. Available at SSRN:

[5] Martin F. J. Prachowny. "Okun's Law: Theoretical Foundations and Revised Estimates." The Review of Economics and Statistics 75, no. 2 (1993): 331–36. https://doi.org/10.2307/2109440.