Economic Indicators Statistical Analysis

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Introduction:

Hello, this is a project I did in R using the Federal Funds Rate, Unemployment Rate, and the Consumer Price Index for each month from 1960-2022 in the United States. The point of this project is to find out the relationship that CPI (inflation indicator) has on unemployment rates and federal funds rates. For my final project when I was in school I was able to find that the relationship between CPI and unemployment rates was practically nonexistent, at least in the United Kingdom. That project also disproved the outdated 'Phillips Curve' theory which stated that inflation and unemployment rates had/ has an inverse relationship. The point of this project has three main statistical objectives: 1). To further reinforce that the Phillips Curve theory is non-existent. 2). To find the relationship between the Consumer Price Index and the Federal Funds Rate, which has lots of relevance at the time of writing this (7/16/23), as the Federal Reserve went on a streak of increasing the Federal Funds rate in an attempt to cool the pace of inflation. This idea is known as Monetary policy tightening, as interest rates have increased the idea is that aggregate demand will be reduced, there will be less investments, and a lower money supply because of the higher interest rates the Fed charges to banks. 3.) The relationship between CPI and Unemployment Rates and the FFR (at once). There is no real economic idea behind this, but I am doing this to make a multivariate linear regression model.

Line Graph of CPI.US, Unemployment, and Federal Funds Rate

Summary Statistics:

This section will describe the summary statistics of each of the three variables and their histogram of the distribution of the data.

CPI Summary:

In the summary statistics below, we can see that the mean and median are almost identical, however, the mean does outstrip the median barely, so the data has a slight positive skew (or right), which you can see in the Histogram below, however, the data looks to be a lot closer to a unimodal distribution, as that makes sense as CPI has generally stayed around 0 - 1 % since 1960 monthly. The standard deviation in this data set is .36, which indicates that on average the data points of the CPI variable are typically around .36 units away from the mean of .31, however as that number might look small, it is not as the histogram shows almost all the data set in within -1.5 to 1.5 in values.

```
##      vars    n mean   SD median  trimmed  mad   min  max range skew kurtosis   se
## X1      1  760 0.31 0.36   0.29     0.29 0.33 -1.92 1.81  3.73 0.07     2.77
0.01
```

Histogram of CPI from 1960-2022
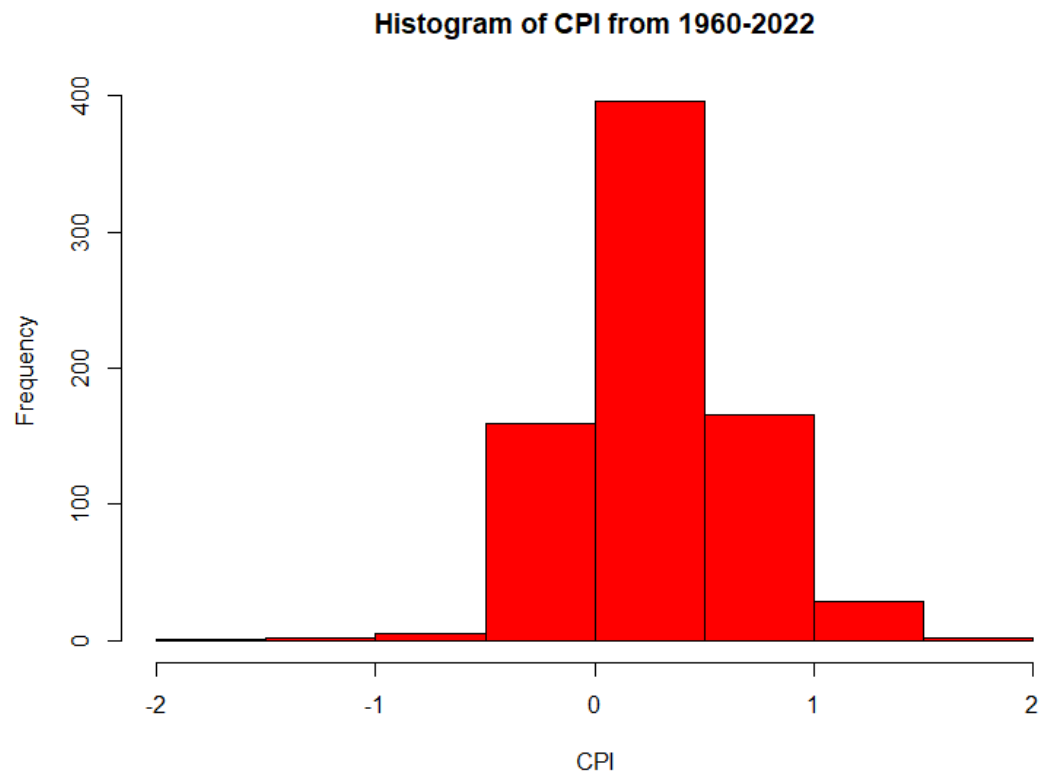
Unemployment Summary:

Here we can see that the mean is outpacing the median which would indicate that the data is right-skewed, which can be confirmed by the histogram as there is a clear right skew near the beginning of the histogram for unemployment rates. This makes sense as unemployment has rarely ever shot passed 6% in modern times but has during times of crisis such as the COVID-19 Pandemic Recession and the Great Recession. The majority of the data happens between the intervals of values under 4% to around 10%. The standard deviation of 1.69 is relatively high respective to the dataset, this means on average the data points of the unemployment rate on average difference about 1.69 units away from the mean.

```
##    vars    n mean    sd median trimmed mad min max range skew kurtosis se
## X1    1 760 5.94 1.69   5.65    5.79 1.56 3.4 14.7 11.3 0.89     1.05 0.06
```

Histogram of Unemployment from 1960-2022
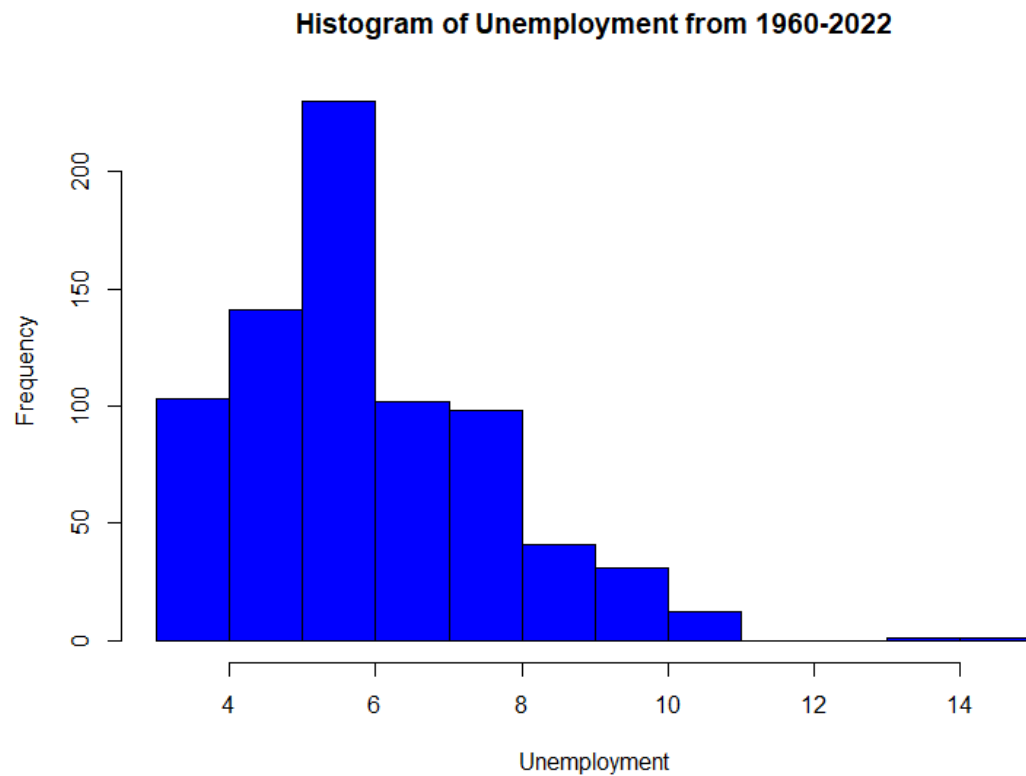
Federal Funds Rate Summary:

Here we can see that the mean of 4.79 outpaced the median of 4.68. This would indicate that the data does have a right skew again, however, if you look at the histogram there are two distinct peaks, one in the '0%' bin and one peak at the '5%' bin. This means the data is a bimodal distribution with a right skew. Most of the data happens within the 0 to 10% range, however, there is enough data past the '10%' to justify saying there is a right skew. The standard deviation of 3.69 is relatively high considering the values of the data set are between the interval of 0 to 20.

```
##      vars   n mean   SD median trimmed  mad  min   max range skew kurtosis
se
## X1     1 760 4.79 3.69   4.68    4.44 3.57 0.05 19.1 19.05 0.95     1.27
0.13
```

Histogram of Federal Funds Rate from 1960-2022
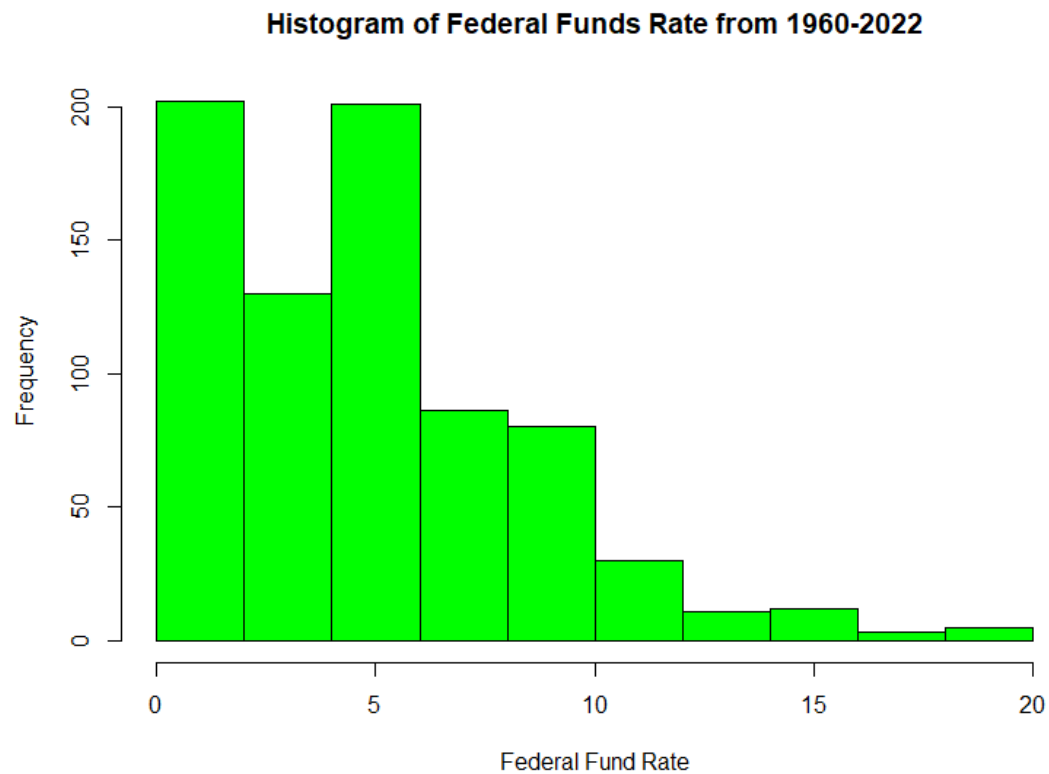
Correlation Plots and Matrix:

Here is where we start to get into the real analysis. First is a correlation test between all three of the variables. Correlation tells us in what direction if any the relationship points towards and how strong the relationship is. The only correlation worth mentioning is the correlation between CPI and the Federal funds rate which a +.4306, which indicates a moderately positive relationship between the two variables, which can be seen below in the scatter graph plot between the two variables. The unemployment rate and CPI share practically no relationship with a -.016 correlation, and the scatter graph between the two variables indicates there is no pattern present in the graph or relationship at all, which further enforces my previous paper (as mentioned before) that disproved the idea of the Phillips Curve. The last relationship that should be thrown out as well is the Unemployment Rate and the federal funds rate, with a correlation of .051, which is a very weak correlation, the scatter graph also confirms this relationship, there is no real pattern to these variables in the graph. However, correlation does not equal causation and more analysis will need to be done.

```
##                UNEMPLOYMENT    FEDFUNDS       CPI.US
## UNEMPLOYMENT    1.00000000  0.05118402  -0.01546201
## FEDFUNDS        0.05118402  1.00000000   0.43061609
## CPI.US         -0.01546201  0.43061609   1.00000000
```
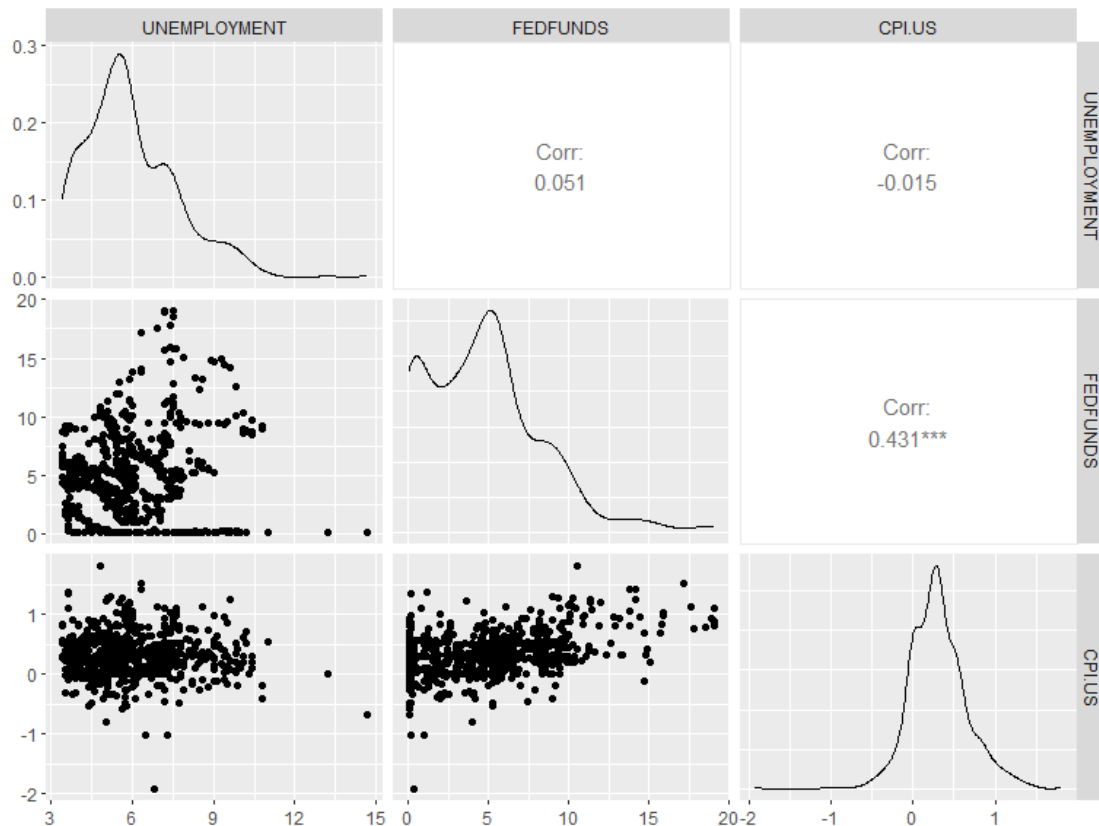
Linear Regression Models:

Here we will get a better understanding of the relationships between the variables via Linear Regression models.

CPI and Unemployment LR:

As expected, the relationship between CPI and Unemployment is practically non-existent. An R-Squared of .0002391 and a p-value of .6704 and an f-stat of .1813 means that there is almost literally no relationship via the R-Squared value, and the p-value is well above the common threshold of .05 and a low F-stat of .1813 means practically no effect was observed and there is a significant lack of a relationship. The scatter graph also visually shows the weak R / linear regression formula. If this doesn't disprove the Phillips Curve theory, I don't know what will. The Residual plots also show no relationship, however, the normality plot is rather linear which does indicate the data is relatively normally distributed.

```
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.22550 -0.23573 -0.01541  0.20305  1.49789
##
## Coefficients:
```

```
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)        0.327965   0.047910   6.845 1.57e-11 ***
## data$UNEMPLOYMENT -0.003303   0.007759  -0.426     0.67
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3606 on 758 degrees of freedom
## Multiple R-squared:  0.0002391, Adjusted R-squared:  -0.00108
## F-statistic: 0.1813 on 1 and 758 DF,  p-value: 0.6704
```

Normal Q-Q Plot
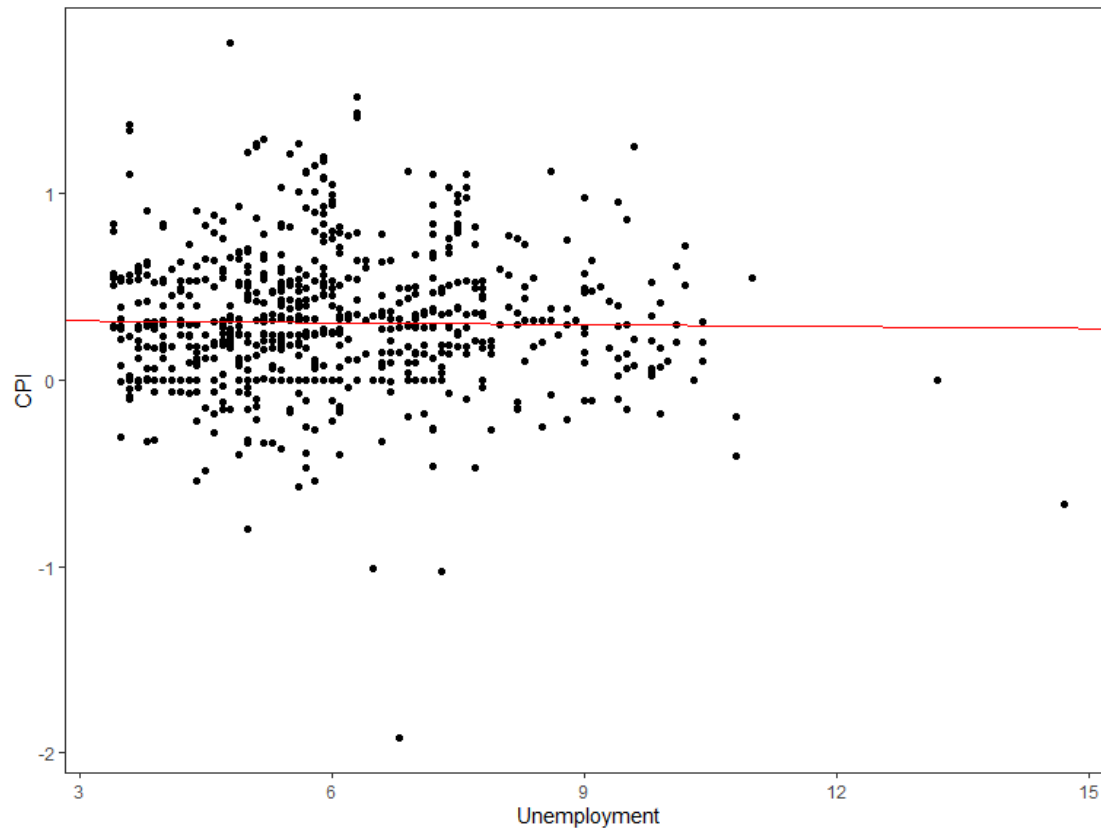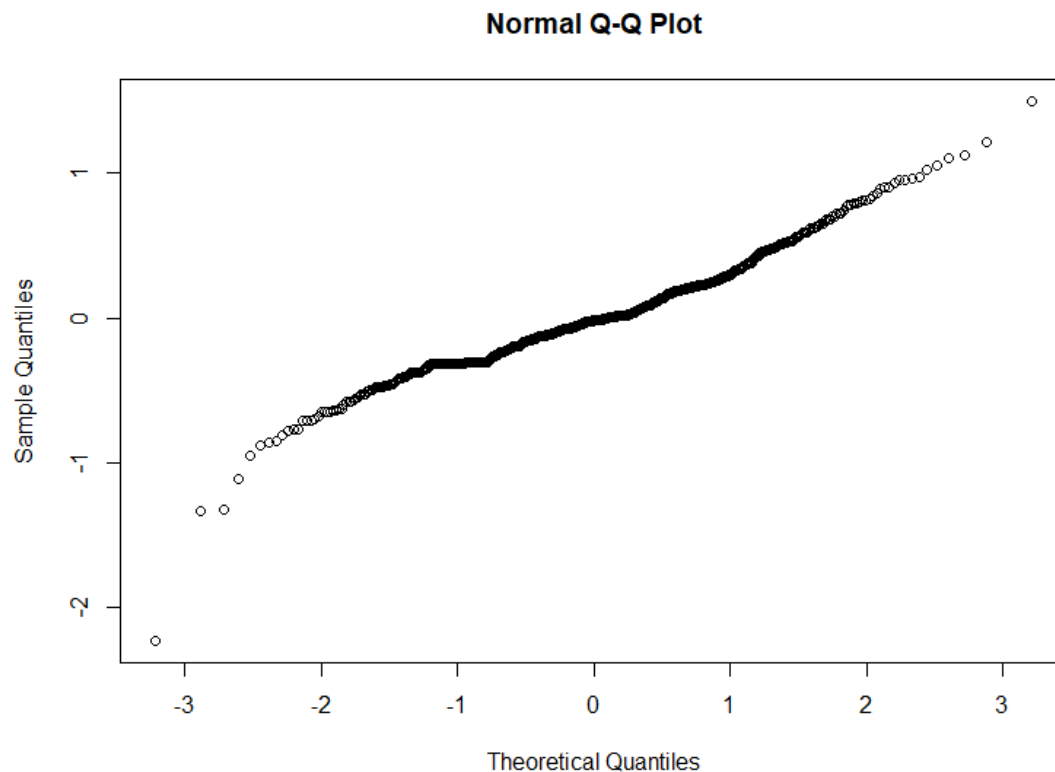
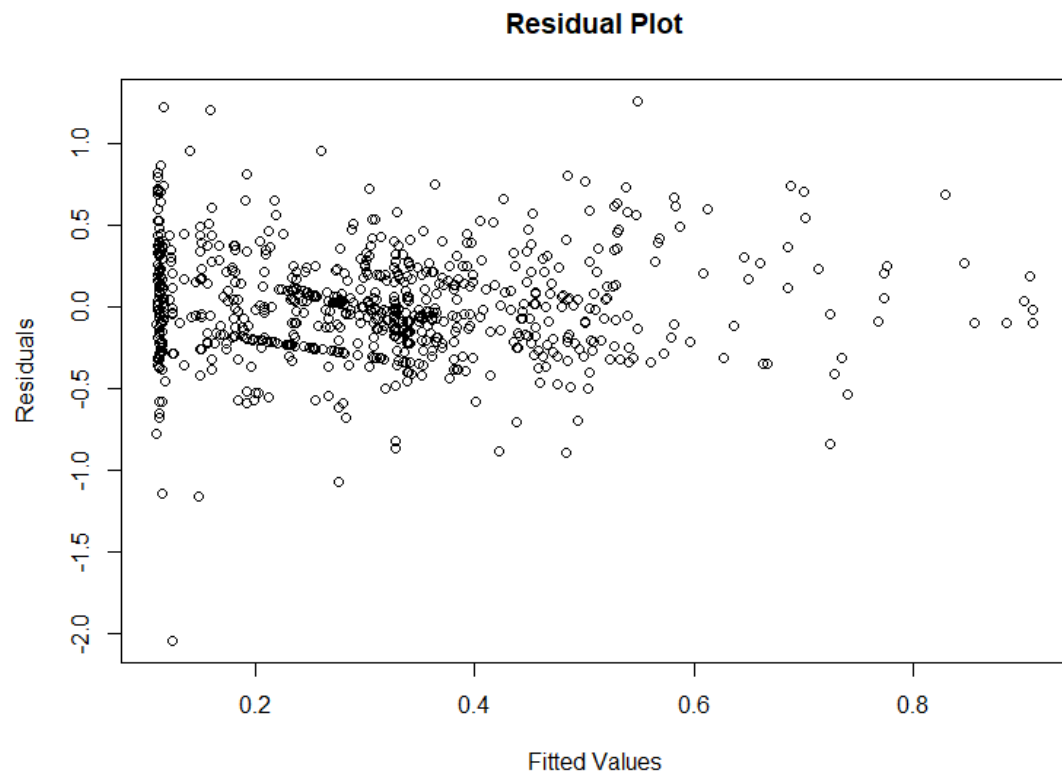
CPI and Federal Funds Rate LR:

As noted above this relationship was the only one worth diving into. As we can see below the R-Square of .1854 is relatively still low. I would classify the relationship between CPI and the FFR rate as a weak positive relationship. The R-Square tells us that only about 18.54% of the variation in the data points in the CPI variable can be explained by the variation in the data points in the Federal Funds Rate. The p-value is very small, the value that returned was in notation, and the F-stat of 172.6 indicates there was a significant relationship observed and we can conclude that these variables do share a significant relationship, albeit rather weak. The scatter graph plot below also visually represents the R-Squared regression line. The normality plot tells us that most of the data is normally distributed. This analysis does make sense as throughout recent history the Federal Reserve has turned to raising the FFR in times of high inflation growth, however, I think it is fair to say that this is probably not the greatest analysis to use as it takes time for inflation to cool after increasing the FFR, inflation does not change overnight, so maybe a different analysis such as a Time Series Analysis would be better for these variables.

```
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.04334 -0.21560 -0.02047  0.19733  1.26151
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.106937   0.019351   5.526 4.51e-08 ***
```
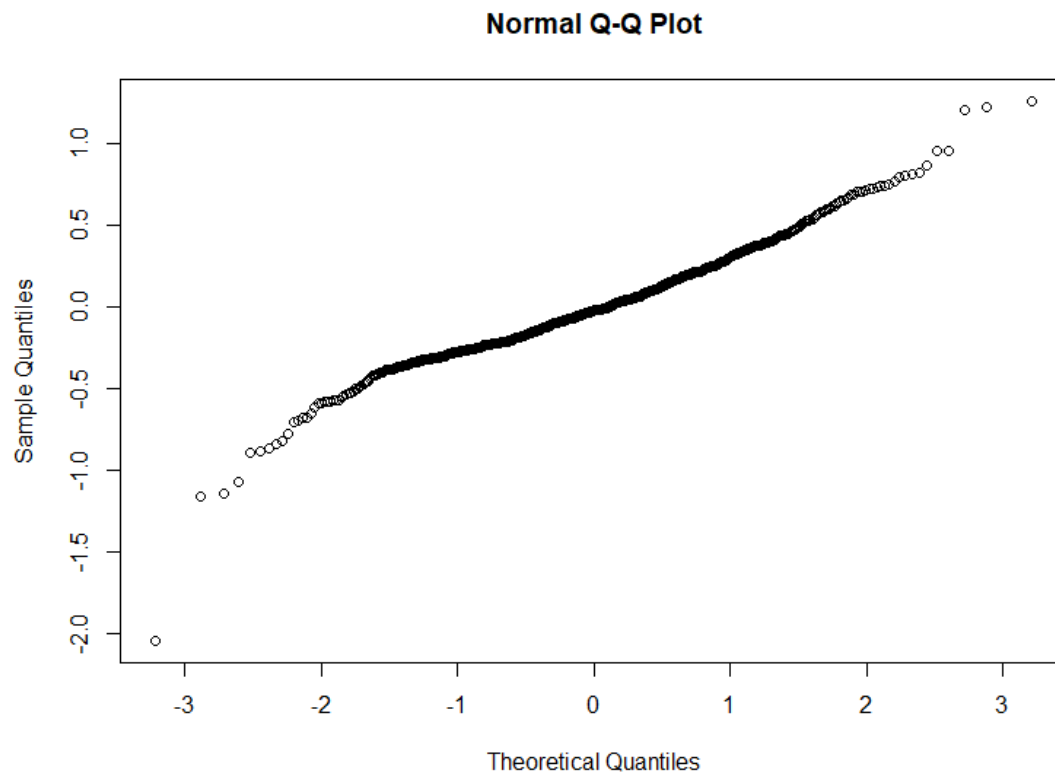
```
## data$FEDFUNDS 0.042053   0.003201  13.136  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3255 on 758 degrees of freedom
## Multiple R-squared:  0.1854, Adjusted R-squared:  0.1844
## F-statistic: 172.6 on 1 and 758 DF,  p-value: < 2.2e-16
```

Residual Plot
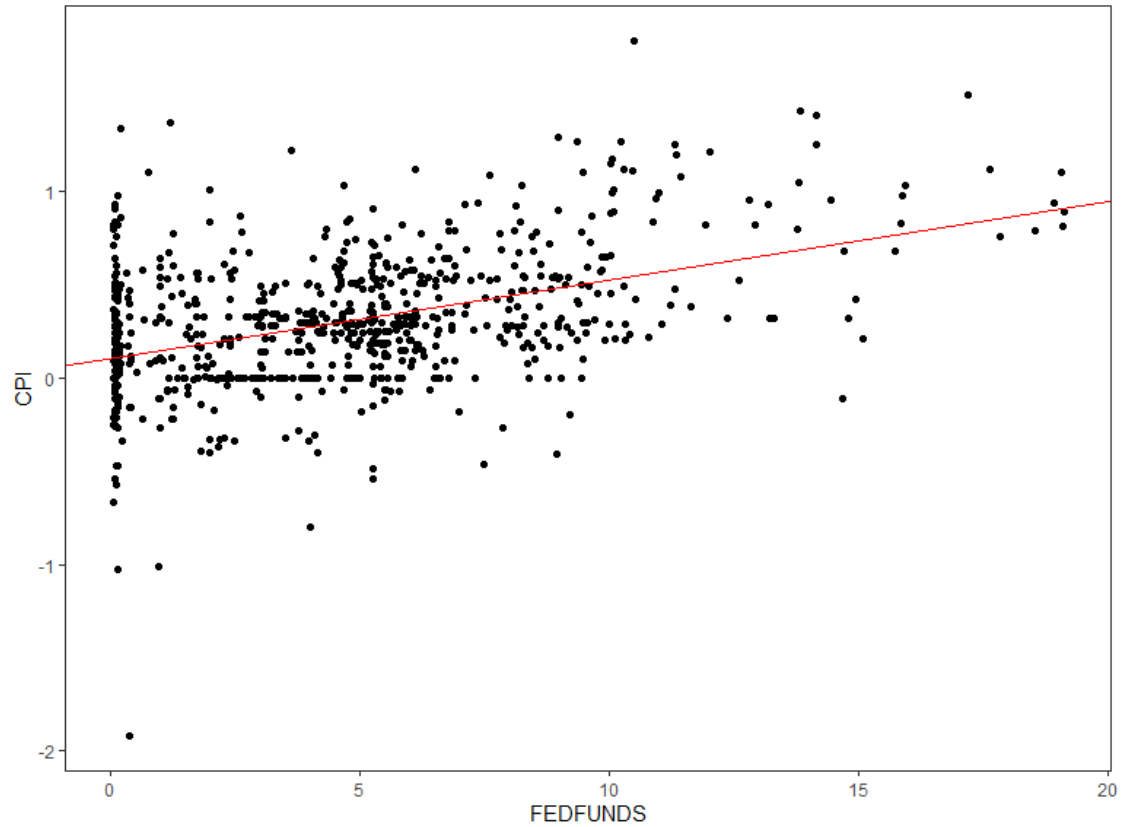

```
qqnorm(residuals1)
```

Normal Q-Q Plot

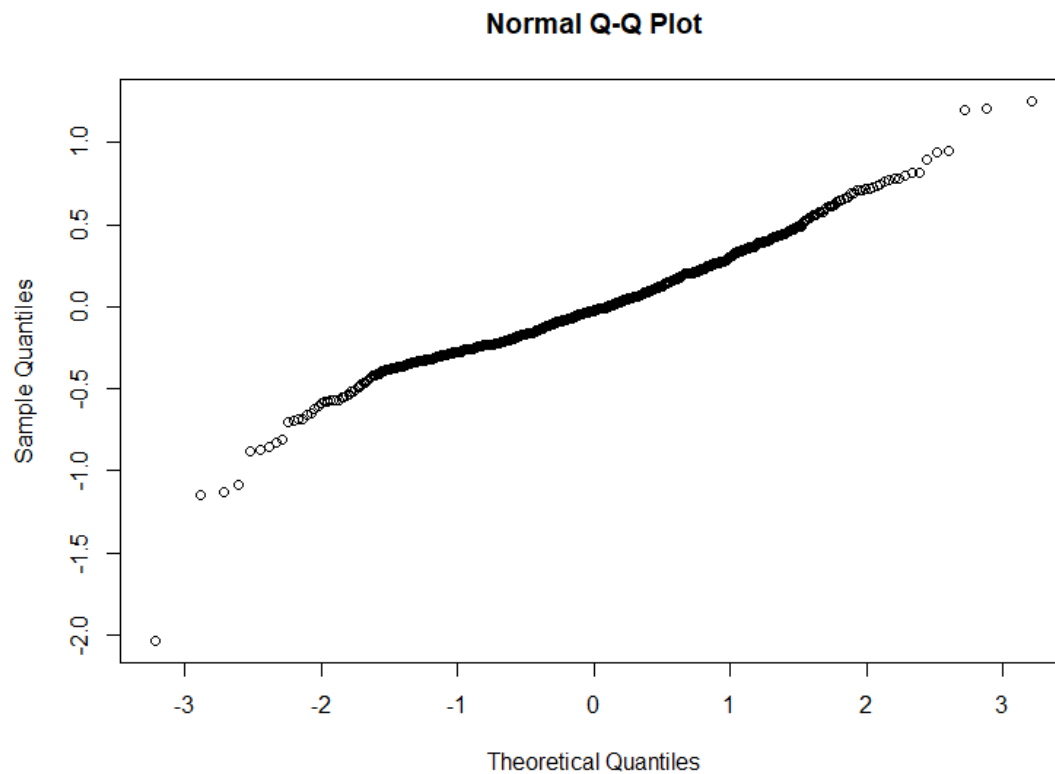
CPI, Unemployment, and Federal Funds Rate LR:

This is a multivariate linear regression model, with CPI being the dependent variable and Unemployment and the FFR being the independent variables. Below we can an R-Squared of .1868, which is higher than the R-Squared values of the previous model. This means that 18.68% of the variation in CPI can be explained by variations in unemployment and the federal funds rate at the same time. Albeit it weak and a p-value of something in the scientific notation, and a rather high f-stat of 86.97, we can conclude that the relationship between the three variables is statistically significant. This is surprising as this is indeed the highest R-Squared score out of all the three models, however, obviously many more factors are driving all of these variables which makes sense when you look at the sheer size and complexity of today's world economy.

```
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.03560 -0.21481 -0.02433 0.19905  1.25127
##
## Coefficients:
##                     Estimate Std. Error t value PR(>|t|)
## (Intercept)         0.153756   0.045212   3.401 0.000707 ***
## data$FEDFUNDS       0.042241   0.003205  13.180  < 2e-16 ***
## data$UNEMPLOYMENT  -0.008033   0.007011  -1.146 0.252258
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3254 on 757 degrees of freedom
## Multiple R-squared:  0.1868, Adjusted R-squared:  0.1847
## F-statistic: 86.97 on 2 and 757 DF,  p-value: < 2.2e-16
```

Residual Plot

Normal Q-Q Plot

Conclusion:

To close out the point of this project was to find the statistical relationships between the variables of the Consumer Price Index, the Unemployment Rate, and the Federal Funds Rate of the United States for every month of the years 1960-2022. This project further reinforces that the Phillips Curve theory is no longer a viable economic theory, or at least the original concept, as there have been numerous updates to the theory. The idea that CPI and the Federal Funds rate have a somewhat positive relationship makes sense to me, especially considering the current status of world affairs (July 2023), as the Federal Reserve increased the Federal funds rate in an attempt to quell the pace of inflation, as of writing this it appears their efforts have worked, but hopefully, these interest rate hikes do not push the US into recession. However, one downside was that I used a Linear Regression Model for this analysis, which is not the best method because inflation does not change overnight, it takes months, sometimes years for inflation %'s to change, so a better method would have been something like a Time Series Analysis. Lastly, the multivariate linear regression model had the highest R-Squared out of the three models albeit still very weak, which is surprising to me as there are another 760 data points in play with the additional variable. There is no real economic idea behind this, or at least one that I know of, but it was interesting to see the results.

References

- *Unemployment Rate Not Seasonally Adjusted.* FRED (2023, July 15). Retrieved from https://fred.stlouisfed.org/series/UNRATE#0
- *Consumer Price Index: Total All Items for the United States.* (2023, July 15). Retrieved from https://fred.stlouisfed.org/series/CPALTT01USM657N
- *Federal Funds Effective Rate.* (2023, July 15). Retrieved from https://fred.stlouisfed.org/series/FEDFUNDS