CAUSALITY BETWEEN UNEMPLOYMENT & INFLATIN IN US ECONOMY

Nil Taşpınar

Koç University

January 12, 2024

I. Introduction

Fiscal policy refers to the changes in government spending and taxes to fight recessions or inflations. When economies witness a recession, fiscal policy can be used to close the recessionary gap, which is the difference between the quantity of output the economy is producing and its potential. With an expansionary fiscal policy, an increase in government spending or a decrease in taxes would increase the aggregate demand. As a result, real GDP increases and the recession fades out. But unfortunately, the price level is higher at the new equilibrium. This means the economy experienced some inflation as a result of the fiscal policy that cured the recession. On the contrary, when there is inflation in an economy, fiscal policy can be used as a remedy to close the inflationary gap. The situation is not good when the economy is producing more than its potential. Inflation is typical during these times. Resources are being strained and the economy may be overheating. The appropriate fiscal policy to close an inflationary gap is to decrease government spending and/or increase taxes. These policies result in a surplus. With a contractionary fiscal policy, aggregate demand decreases and at the new level of output, there is no longer an inflationary gap; in fact, the price level is lower at the new equilibrium. But since the real GDP declines, the unemployment rate increases and this is a sign of a recession risk. Thus, we can say that fiscal policy has its drawbacks. A fiscal policy designed to remedy a recession will result in inflation. Similarly, a fiscal policy designed to combat inflation will result in declines in output and possibly a recession. It seems that fiscal policy cannot remedy both unemployment and inflation at the same time. The idea of inflation and unemployment moving in opposite directions was first noticed by a British economist, A. W. Phillips. He discovered that when inflation was high, unemployment was low and when inflation was low, unemployment tended to be high. Unemployment and inflation behaved according to this relationship in the US in the 1960s, but the 1970s defied the Phillips tradeoff—both inflation and unemployment were high in the mid-1970s. The reason for this inverse relationship which was present in the 1960s was due to the shifts of the aggregate demand curve. But in the 1970s, the economy experienced stagflation, which is the situation when the economy experiences inflation and a recession simultaneously. As it is known, stagflation occurs whenever the aggregate supply curve shifts to the left, since both inflation and unemployment are rising (contradicting with the Phillips relationship). This is the major drawback of fiscal policy. It cannot cope with stagflation because it can remedy only one problem at the expense of another. When both inflation and unemployment occur simultaneously, fiscal policy is not appropriate. The true solution to stagflation is to get the aggregate supply curve to shift back to the right. This can be accomplished by making resources more available or a technological advance. There are no standard government policies that can accomplish this quickly and effectively. Supply-side economics is an attempt to shift the aggregate supply curve to the right to cure stagflation.

Supply-side economists recommend special tax policies and less government regulation to accomplish the task.

The study aims to analyze the relationship between inflation and unemployment in the US economy. Previous studies show varying results regarding the relationship between inflation and unemployment in different countries, such as one-way causality, two-way causality, and no causal relationship between inflation and unemployment. According to Özen (2022), there is a unidirectional causality relationship between unemployment and inflation variables for selected OECD countries (France, Australia, Canada, Germany, Iceland, Poland, Italy, Spain, Portugal and Turkey) for the years 2010-2020. The causality is observed from unemployment to inflation but not vice versa. However in the research conducted for East Java covering the period between 1999-2014, Setiawan (2015), we observe the causality in reverse direction such that the unemployment rate influences the level of inflation but inflation does not influence the level of unemployment. Similarly, Alper (2017) tests the validity of the Phillips Curve throughout the years 1987-2016 by the ARDL approach regarding the Turkish economy. According to the results, there is no long-term relationship between the variables in the model where inflation is considered as the dependent variable. But when the unemployment rate is taken as the dependent variable, the existence of a long-run relationship is determined. Our results also coincide with Ştefan and Bratu (2016), where they document the one-way relationship between inflation and unemployment, suggesting that inflation explains unemployment but not vice versa. Finally, the methodology we refer to in our study is similar to the one used by Sasongko and Huruta (2019), where they analyze the causal relationship between unemployment and inflation in Indonesia covering periods from 1984 to 2017.

Considering previous literature, we aim to analyze the causal relationship between unemployment and inflation in the US economy and we investigate the following:

Does knowing the inflation is useful for predicting the unemployment level or vice versa?

In the following section, we will first present the data. Then in the third section, each variable's time series plot will be analyzed to understand in which periods the inverse relationship was present and interpret if it is in line with the presented economic theory. Then, in the fourth section, we will conduct a Granger causality test to determine whether or not one time series is useful for forecasting another, using the Bayesian information criterion to select the optimal lag length. Further, we will run the vector autoregression after completing the Granger causality test since VAR is commonly used for forecasting systems of interrelated time series and for analyzing the dynamic impact of random disturbances on the system of variables. Finally, we will try to suggest a possible methodology to properly state a relationship between inflation and unemployment by suggesting an instrumental variable. In the last section, we conclude.

II. Data

In our analysis, we are using the data of ”FRED Economic Data – St. Louis FED” which contains frequently updated US macro and regional economic time series at annual, quarterly, monthly, weekly, and daily frequencies. In our analysis, we will observe quarterly statistics. More specifically, the study relies on the time-series data from 1960-Q1 to 2023-Q3.

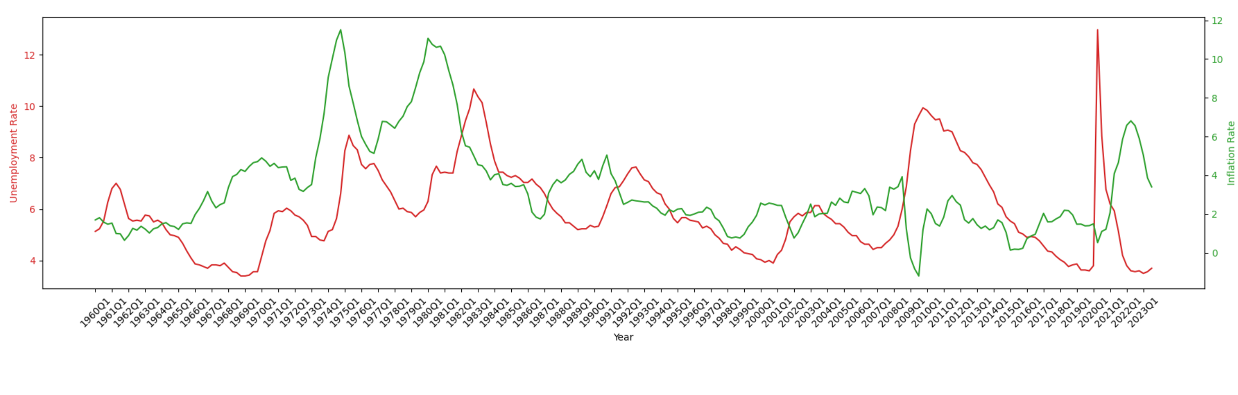
- For unemployment, we use seasonally adjusted quarterly *Unemployment Rate* (Percent).
- For inflation, we refer to the seasonally adjusted quarterly *Personal Consumption Expenditures (PCE)*: Chain-type Price Index (Percent Change from Year Ago).

As we will see in the further sections, we observe that there is a one-way causality between inflation and unemployment such that inflation explains unemployment. However explaining the unemployment rate only by inflation is not possible due to omitted variable bias and since the error term in the regression is probably correlated with the explanatory variable, which in our case is inflation; we face an endogeneity problem. To overcome the endogeneity, we try to propose an instrumental variable. The aim of the 2SLS regression is not to observe the true effect of inflation on unemployment, because the omitted variables bias will be still present. But to be able to find a relevant instrument for inflation, so that in further studies when a multiple regression analysis is conducted for the unemployment rate, determination of a proper instrument for inflation can be selected. As an instrumental variable, we use national defense expenditures.

- For national defense expenditures, we prefer seasonally adjusted quarterly *Federal Government: National Defense Consumption Expenditures and Gross Investment* (Percent Change from Year Ago).

III. Unemployment Rate and Personal Consumption Expenditure between 1960-2023

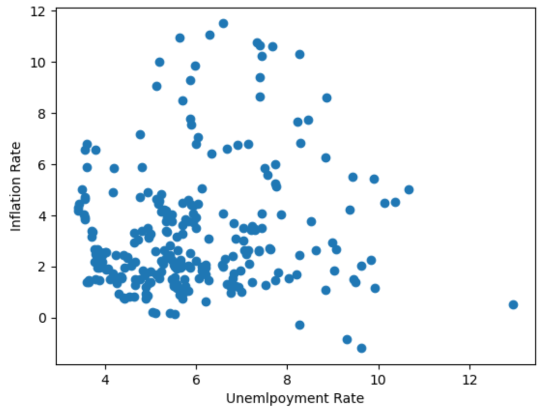
Before we start the causality analysis, we analyze the time series of inflation and unemployment separately between 1960 Q1 – 2023 Q3 in the US. The quarterly Personal Consumption Expenditures (PCE) and Unemployment Rate graph are presented below.



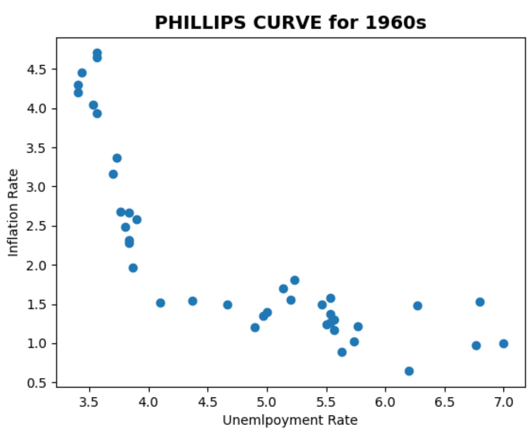
The green line represents the inflation rate and the related ratios for the inflation rate are observed on the right-side axis. The red line is for the unemployment rate and the ratios regarding the unemployment rate are shown on the left-side axis.

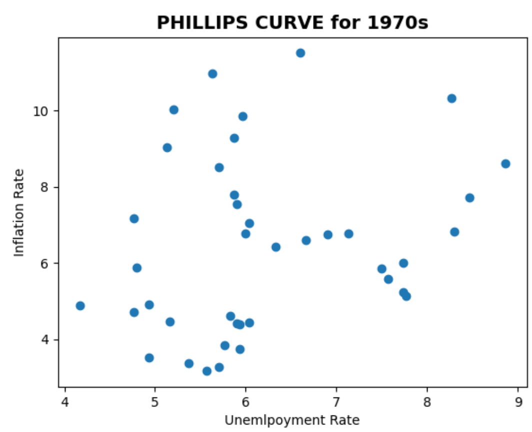
As can be seen from the figure above, during the 1960s, there appears to be an inverse relationship between inflation and unemployment. When inflation is high, the unemployment rate is low and there is an increase in the unemployment rate when the inflation rate decreases. This opposite relationship is in line with the Phillips curve. But in the first half of the 1970s, this relationship turns in the opposite direction. Inflation and unemployment rates increase at the same time, so the economy witnesses a state of stagflation. Starting from the mid-70s till the end of the 1990s, there is no obvious relationship between two variables that can be deducted from the graph. For example, during the mid-80s two curves intersect. From the point where they coincide, the inflation rate increases and the unemployment rate decreases. But between the mid-90s and 1999-Q1, it seems that both inflation and unemployment rates tend to decrease. Thus, we cannot conclude a direct relationship between these variables for the periods between 1975 and 2000. However, in the last 20 years, the relationship between inflation and the unemployment rate shows that there is a dynamic similar to the Phillips curve since inflation and unemployment curves start to diverge from each other.

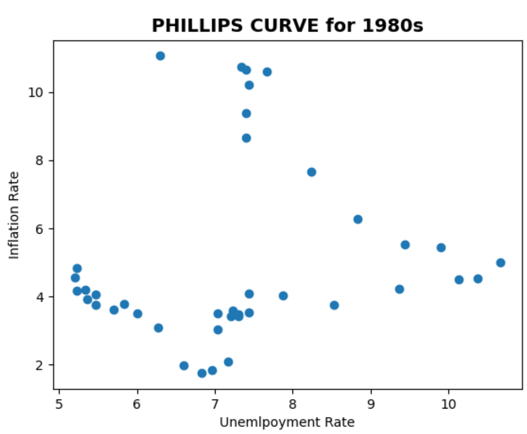
In order to have a better understanding and observe if there is a resemblance with the original Phillips curve, we plot the scatter plot for inflation and unemployment, where the y-axis presents the inflation rate and the x-axis shows the unemployment rate. As it can be seen below, when we put every single quarter combination, we observe a scatter distribution.

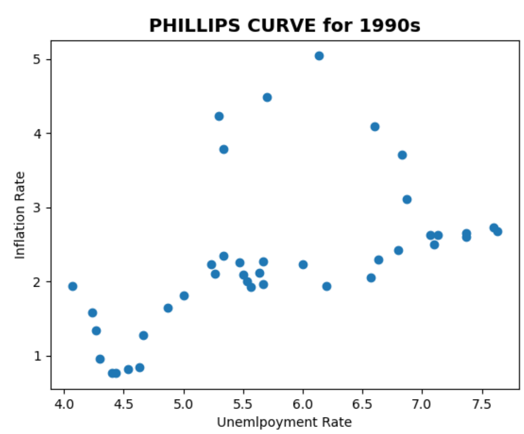


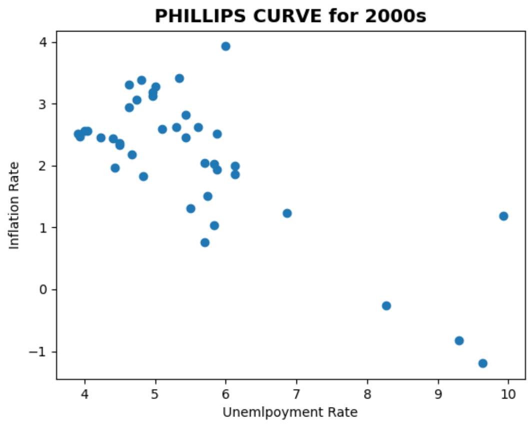
To see the inverse relationship, we present the scatter plots for each decade separately. According to the scatter plots presented below, as we have previously discussed, the inverse relationships are more apparent in the 1960s, 2000s, and 2020s.

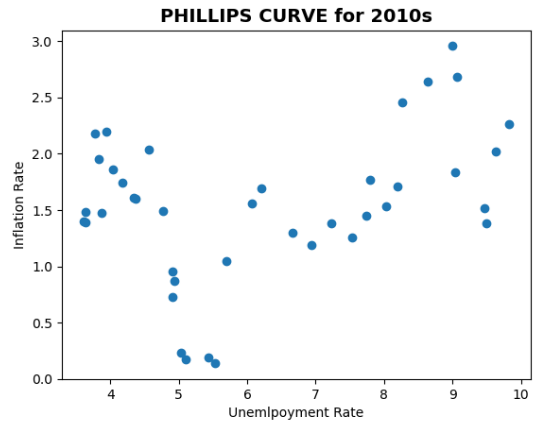


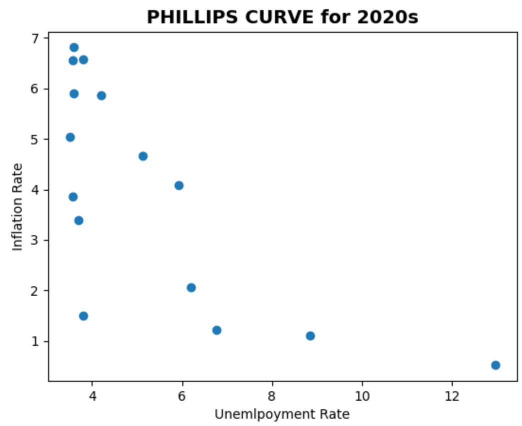




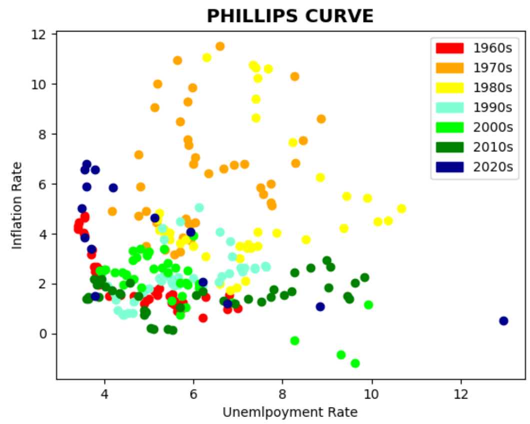








Finally, we introduce *inflation and unemployment rate combinations* of each decade using different colors on a single scatter plot. Red points are for the 1960s, orange is for the 1970s, yellow is for the 1980s, turquoise is for the 1990s, light green is for the 2000s, dark green is for the 2010s, and dark blue is for the 2020s.



In conclusion, in some periods, inflation and unemployment move in opposite directions. But this phenomenon is not apparent in every decade. Thus, there is no specific relationship that can be deducted for these two variables according to their historical time series data.

IV. Causality Analysis

The aim of the study is the analyze the causal relationship between inflation and unemployment. As we have previously mentioned, the studies regarding the relationship between inflation and unemployment vary across countries and according to the period the study is based on, such as one-way causality, two-way causality, and no causal relationship between inflation and unemployment. In order to observe the causal relation and analyze the data, we use the Granger causality test and vector autoregression model.

The Granger causality test is a statistical hypothesis test used to determine whether one time series can be used to predict another. The term "granger-causes" means that knowing the value of the *"unemployment"* time series at a certain lag is useful for predicting the value of the "*inflation"* time series at a later period. This test produces an F-test statistic with a corresponding p-value. If the p-value is less than a certain significance level, then we reject the null hypothesis and conclude that we have sufficient evidence to say that the unemployment time series granger-causes inflation time series. We also apply the granger-causality test in reverse to observe if reverse causation is present. Finally, can interpret the relationship between inflation and unemployment for the US economy considering the quarterly data from 1960-Q1 to 2023-Q3.

The vector autoregression (VAR) model is a statistical method used for time series analysis that extends the idea of autoregression to multiple variables. VAR models are commonly employed in econometrics and other fields to capture the joint dynamics and interdependencies among multiple time series variables. These models are particularly useful for causality analysis between variables.

The vector autoregressive model of order p, denoted as VAR(p), for unemployment and inflation time series is as follows:

$$UNEM_t \ = \propto_1 + \ UNEM_{t-1} + \ \cdots \ UNEM_{t-p} + \ INF_{t-1} + \ \cdots \ INF_{t-p} + \varepsilon_{t,1}$$

$$INF_t \ = \propto_2 + \ INF_{t-1} + \ \cdots \ INF_{t-p} + \ UNEM_{t-1} + \ \cdots \ UNEM_{t-p} + \varepsilon_{t,2}$$

Before running the Granger Causality and Vector Autoregression model, we initially need to determine the optimal lag length. The selection of the optimal lag length in time series analysis is crucial for obtaining reliable and efficient results. There are various approaches to select the optimal lag length, the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) are commonly used for this purpose. In our study, we use the Bayesian Information Criterion (BIC) since it tends to select a simpler model with fewer lags, helping to prevent overfitting and since it is consistent, meaning that as the sample size increases, the probability of selecting the correct model converges to one (this property is desirable for selecting a lag length that generalizes well to new data) compared to AIC. BIC provides a balance between model fit and model simplicity, aiming to prevent overfitting by penalizing models with more parameters. The formula for BIC is:

$$BIC = -2 \cdot \ln(L) + k \cdot \ln(n)$$

where:

- L is the likelihood of the model given the data.
- k is the number of parameters in the model.
- n is the sample size.

We calculate the BIC for each lag, the optimal lag will be the one with the lowest BIC value. After introducing the methodology we dispose of, we can move on to sharing our results. To calculate the BIC, we set the maximum lag length to 10. Note that the result doesn't change with the max-value which is manually imposed. The BIC value for each lag is reported below.

```
BIC values for each lag length:
Lag 1: 0.687713974366396
Lag 2: 6.280029169049655
Lag 3: 15.455398372124996
Lag 4: 26.0727336921494
Lag 5: 36.85497168419078
Lag 6: 42.930993145717494
Lag 7: 54.23739227682361
Lag 8: 65.8594328455003
Lag 9: 75.61471920550193
Lag 10: 81.37808090784482

Optimal BIC value: 0.687713974366396
Optimal lag determined by BIC: 1
```

As can be seen from the table above, the minimum BIC value is 0.6877. Thus the optimal lag length for the causality analysis is 1. We use lag 1 to investigate the causality between inflation and unemployment.

i) Granger Causality Test

After determining the lag length, we implement the Granger causality test. First, we check whether past values of the unemployment time series can predict the future inflation time series. We form the following null and alternative hypotheses for our test.

– Null Hypothesis (H_0): unemployment time series *does not* granger-cause inflation time series

– Alternative Hypothesis (H_A): unemployment time series granger-cause inflation time series

The results of the Granger causality test are presented below.

```
Granger Causality
number of lags (no zero) 1
ssr based F test:         F=2.7931  , p=0.0959  , df_denom=251, df_num=1
ssr based chi2 test:   chi2=2.8265  , p=0.0927  , df=1
likelihood ratio test: chi2=2.8108  , p=0.0936  , df=1
parameter F test:         F=2.7931  , p=0.0959  , df_denom=251, df_num=1
```

The F-test statistic turns out to be 2.7931 and the corresponding p-value is 0.0959. Since the p-value is greater than 0.05, we can't reject the null hypothesis of the test and conclude that knowing the unemployment rate is not useful for predicting the future inflation rate. Thus, we conclude that the unemployment time series *doesn't* granger-causes the inflation time series.

Second, a reverse causality is performed. When we apply the Granger causality test in reverse the results differ. The null and alternative hypotheses to investigate the reverse causality are as follows:

- Null Hypothesis (H_0): inflation time series *does not* granger-cause unemployment time series
- Alternative Hypothesis (H_A): inflation time series granger-cause unemployment time series

The results of the reverse Granger causality test are presented below.

```
Granger Causality
number of lags (no zero) 1
ssr based F test:         F=5.1889  , p=0.0236  , df_denom=251, df_num=1
ssr based chi2 test:   chi2=5.2509  , p=0.0219  , df=1
likelihood ratio test: chi2=5.1974  , p=0.0226  , df=1
parameter F test:         F=5.1889  , p=0.0236  , df_denom=251, df_num=1
```

The F-test statistic turns out to be 5.1889 and the corresponding p-value is 0.0236. Since the p-value is less than 0.05, we reject the null hypothesis of the test and conclude that knowing the inflation rate is useful for predicting the future unemployment rate. Thus, we can say that the inflation time series *does* Granger-causes unemployment time series.

ii) Vector Autoregression Model

Further, we run a vector autoregression model after completing the Granger causality test.

Since the lag length is equal to 1, we form a VAR(1) model as follows:

$$UNEM_t = \propto_1 + UNEM_{t-1} + INF_{t-1} + \varepsilon_{t,1}$$

$$INF_t = \propto_2 + INF_{t-1} + UNEM_{t-1} + \varepsilon_{t,2}$$

The results which are in line with the Granger causality test, are presented below.

```
Summary of Regression Results
==================================
Model:                         VAR
Method:                        OLS
Date:           Tue, 02, Jan, 2024
Time:                     08:58:22
--------------------------------------------------------------------
No. of Equations:         2.00000    BIC:                  -1.82917
Nobs:                     254.000    HQIC:                 -1.87911
Log likelihood:          -471.904    FPE:                  0.147677
AIC:                     -1.91273    Det(Omega_mle):       0.144250
--------------------------------------------------------------------
Results for equation unemployment_rate
=======================================================================================
                        coefficient       std. error           t-stat            prob
---------------------------------------------------------------------------------------
const                      0.430553         0.167464            2.571           0.010
L1.unemployment_rate       0.903219         0.026486           34.102           0.000
L1.inflation               0.041773         0.018338            2.278           0.023
=======================================================================================

Results for equation inflation
=======================================================================================
                        coefficient       std. error           t-stat            prob
---------------------------------------------------------------------------------------
const                      0.296543         0.132649            2.236           0.025
L1.unemployment_rate      -0.035062         0.020980           -1.671           0.095
L1.inflation               0.975269         0.014526           67.140           0.000
=======================================================================================

Correlation matrix of residuals
                     unemployment_rate  inflation
unemployment_rate             1.000000  -0.251068
inflation                    -0.251068   1.000000
```

```
Parameters:
                      unemployment_rate  inflation
const                          0.430553   0.296543
L1.unemployment_rate           0.903219  -0.035062
L1.inflation                   0.041773   0.975269
```

The first part of the results output presents us the model considering the unemployment rate as the dependent variable in a VAR(1) model as follows:

$$UNEM_t = \propto_1 + UNEM_{t-1} + INF_{t-1} + \varepsilon_{t,1}$$

In theory, we assume that the error term follows the normal distribution and because of this the coefficient parameters also have normal distributions.

In addition, t-statistics are calculated by assuming the following hypothesis:

- *H_0: coefficient = 0* *(variable X does not influence Y)*
- *H_A: coefficient ≠ 0* *(X has a significant impact on Y)*

The p-values for $UNEM_{t-1}$and INF_{t-1} variables respectively are 0.000 and 0.023. Since both p-values are less than 0.05, which is the significance level calculated at a 95% confidence interval, we reject the null hypothesis and conclude that if the lagged unemployment rate rises by 1 unit then the unemployment rate increases by 0.9032 and if the lagged inflation rate rises by 1 unit then the unemployment rate increases by 0.0417.

According to the VAR results, the lagged inflation rate affects the unemployment rate, which is also in line with the Granger causality test results.

The second part of the summary of regression results considers the inflation rate as the dependent variable and presents the following relation:

$$INF_t = \propto_2 + INF_{t-1} + UNEM_{t-1} + \varepsilon_{t,2}$$

The p-values for INF_{t-1} and $UNEM_{t-1}$ variables respectively are 0.000 and 0.095. The p-value which is based on the H_0 which states that "*lagged inflation rate has no influence on inflation rate"*, is equal to 0.000. Since it's less than 0.05, we reject the null hypothesis. Moreover, the p-value which is based on the H_0 which states that "*lagged unemployment rate has no influence on inflation rate"*, is 0.095. Since it's greater than 0.05, we cannot reject the null hypothesis and conclude that the lagged unemployment rate doesn't affect the inflation rate. The results are similar to the ones obtained from the previous Granger causality test section.

In conclusion, we obtain the same direction of the causality between the inflation rate and unemployment rate using Granger causality test and vector autoregression model.

V. Possible Methodology Suggestions for Further Research

As we have previously mentioned, we aim to understand the causal relationship between the unemployment rate and the inflation rate using personal consumption expenditures (PCE) as a measure of inflation. Former studies indicated one-way, two-way, and no causal relationship between the inflation rate and unemployment rate. According to the outcomes of Granger causality test and vector autoregression model, we obtain a one-way causal relationship between the inflation rate and unemployment rate. The lagged inflation rate has a significant influence on the unemployment rate.

In this section, first, we run a simple OLS regression to interpret the effect of the inflation rate on the unemployment rate. But due to unobserved variables the regression results in an omitted variable bias. For instance, we know that generally when real GDP increases, the price level increases and the unemployment rate decreases. Thus, omitted variables cause biased results. Instrumental variables offer one approach to estimate the causal effect. So, second, we run a 2SLS regression. However, it is not possible to solve the omitted variable bias problem with the instrumental variable approach that we applied in this study because the selected instrument will not be to able eliminate all possible effects in the error term because of the exclusion of the necessary control variables. However, our aim at this stage is to offer a relevant instrument that can be used instead of the inflation rate for further research that intends to conduct a comprehensive regression analysis in this field.

i) Ordinary Least Squares Regression (OLS)

Ordinary Least Squares regression (OLS) is a common technique for estimating coefficients of linear regression equations which describe the relationship between one or more independent quantitative variables and a dependent variable. The regression of the inflation rate on the unemployment rate is given below.

```
            OLS Regression Results
==============================================================================
Dep. Variable:      unemployment_rate   R-squared:                       0.014
Model:                            OLS   Adj. R-squared:                  0.010
Method:                 Least Squares   F-statistic:                     3.652
Date:                Tue, 02 Jan 2024   Prob (F-statistic):             0.0571
Time:                        17:46:16   Log-Likelihood:                -492.59
No. Observations:                 255   AIC:                             989.2
Df Residuals:                     253   BIC:                             996.3
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          5.6513      0.178     31.797      0.000       5.301       6.001
inflation      0.0829      0.043      1.911      0.057      -0.003       0.168
==============================================================================
Omnibus:                       34.490   Durbin-Watson:                   0.193
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               45.737
Skew:                           0.898   Prob(JB):                     1.17e-10
Kurtosis:                       4.038   Cond. No.                         7.21
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

According to the OLS results, we cannot reject the null hypothesis that "*inflation rate does not influence on unemployment rate"* since the p-value which is equal to 0.057 is less than 0.05. However, we know that there is an endogeneity problem when we regress the inflation rate on the unemployment rate due to the omitted variable bias, and if the intuition about the source of endogeneity is correct, the OLS results should be an overestimate of the effect of the inflation rate.

ii) Two-Stage Least Squares Regression

Two-stage least-squares regression uses instrumental variables that are uncorrelated with the error terms to compute the estimated values of the problematic predictor (the first stage) and then uses the computed value to estimate a linear regression model of the dependent variable (the second stage).

Since we only regress the inflation rate on the unemployment rate, a single instrument will not be able to solve the endogeneity problem. The exclusion of control variables will cause the omitted variable problem. However, our aim is not to predict the true effect of inflation on unemployment but to understand the causal effect's direction and to propose an instrument to use instead of the inflation rate for further research.

In our analysis, the unemployment rate is the dependent variable, and the inflation rate is the explanatory variable. The selection of a valid instrumental variable is not easy. We need to find a variable that is correlated with the inflation rate but not with the error term, thus a variable that satisfies two conditions: relevance and exogeneity.

Our purpose as the instrumental variable is national defense expenditures. As we previously stated, for national defense expenditures, we prefer seasonally adjusted quarterly *Federal Government: National Defense Consumption Expenditures and Gross Investment* (Percent Change from Year Ago).

First, we check whether the instrumental variable satisfies the relevance condition.
Relevance means that the instrumental variable is strongly correlated with the explanatory variable of interest. In order to do so, we fit a simple regression model for the independent and instrumental variable. We check whether the relevance condition is satisfied by observing the p-

value. Since the p-value is equal to *"1.5932270046746205e-10"* which is lower than 0.05, we conclude by stating that the instrumental variable is relevant.

Second, we check whether the instrumental variable satisfies the exogeneity condition.

Exogeneity means that the instrumental variable is independent of the error term and does not affect the outcome variable, through other channels. Exogeneity requires that *Cov(instrumental_variable, error term)=0*, and this cannot be tested. The reason why we think that national defense can be a valid instrument that may satisfy the exogeneity condition, when necessary control variables are added to the regression， is that the national defense expenditures are not decided according to economic conditions, they are mainly driven by political and strategic factors. For instance, according to many economists, Turkey started to witness a recession, and the size of the recession is expected to even increase in the upcoming months. Even though this is the case, the 2024 Defense and Security Budget determined by the authorities recently which is equal to 1 trillion 133.5 billion TL (40 billion 450 million dollars) draws attention. The increase in the budget allocated to the defense seems independent of the economic conditions Turkey is experiencing but does affect the inflation rate. Thus, national defense expenditures may influence the unemployment rate through their effect on the inflation rate.

First-stage regression results show that national defense is a relevant instrument since its t-statistic value is high. However, as we expected, the regression of the predicted effect on the dependent variable is not statistically significant. The endogeneity problem is still present. However under the scope of our analysis, finding a relevant instrument for the inflation rate is obtained. Using national defense expenditure as an instrumental variable might work for further research aiming to find the effect of the inflation rate on the unemployment rate.

```
First Stage Regression Results:
                            OLS Regression Results
==============================================================================
Dep. Variable:              inflation   R-squared:                       0.150
Model:                            OLS   Adj. R-squared:                  0.146
Method:                 Least Squares   F-statistic:                     44.50
Date:                Mon, 25 Dec 2023   Prob (F-statistic):           1.59e-10
Time:                        16:16:51   Log-Likelihood:                -566.62
No. Observations:                 255   AIC:                             1137.
Df Residuals:                     253   BIC:                             1144.
Df Model:                           1
Covariance Type:            nonrobust
====================================================================================
                       coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------------
const                2.5341      0.182     13.926      0.000       2.176       2.892
national_defense     0.1681      0.025      6.671      0.000       0.118       0.218
==============================================================================
Omnibus:                       35.848   Durbin-Watson:                   0.087
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               46.632
Skew:                           0.966   Prob(JB):                     7.48e-11
Kurtosis:                       3.809   Cond. No.                         9.44
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

Second Stage Regression Results:
                            OLS Regression Results
==============================================================================
Dep. Variable:      unemployment_rate   R-squared:                       0.010
Model:                            OLS   Adj. R-squared:                  0.006
Method:                 Least Squares   F-statistic:                     2.490
Date:                Mon, 25 Dec 2023   Prob (F-statistic):              0.116
Time:                        16:16:51   Log-Likelihood:                -493.17
No. Observations:                 255   AIC:                             990.3
Df Residuals:                     253   BIC:                             997.4
Df Model:                           1
Covariance Type:            nonrobust
=============================================================================================
                                coef    std err          t      P>|t|      [0.025      0.975]
---------------------------------------------------------------------------------------------
const                         5.3389      0.386     13.823      0.000       4.578       6.100
predicted_independent_var     0.1774      0.112      1.578      0.116      -0.044       0.399
==============================================================================
Omnibus:                       26.093   Durbin-Watson:                   0.188
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               31.164
Skew:                           0.781   Prob(JB):                     1.71e-07
Kurtosis:                       3.701   Cond. No.                         13.6
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

VI. Conclusion

The aim of the study is to analyze the causal relationship between the inflation rate and the unemployment rate. The relation between these two variables differs according to the fiscal policy that has been applied over the years. During the 1960s, the inflation rate and unemployment rate moved in opposite directions since the fiscal policy which cured the inflationary gap resulted in increased unemployment and the fiscal policy aiming to fight recession caused the rise of prices. However, the relationship between inflation and the unemployment rate turned out to move in the same direction with the existence of stagflation. Thus, the relationship between these two variables differs throughout 1960-2023. We investigated the causal relationship in order to understand which variable can be used to predict future values of the other variable, in other words, whether the inflation rate is used to predict the future unemployment rate or vice versa. According to the results of the Granger causality test and vector autoregression model, we obtain the same direction of causality between the inflation rate and unemployment rate such that the inflation rate has a significant effect on the unemployment rate. However, when we regress the inflation rate on the unemployment rate, we witness omitted variable bias due to the existence of factors in the error term that affect both variables. Finally, we used national defense expenditures as an instrument for the inflation rate. The suggestion of the instrument is to support further research regarding the investigation of the effects of the inflation rate on unemployment, rather than the direction of causality. Since we did not focus directly on the direct effect's magnitude, we did not include any other control variables and aimed to resolve the omitted variable bias problem. In conclusion, the historical data shows that the inflation rate has an observable and significant effect on the unemployment rate, and in order to assess the true effect the determinants that may cause changes in both inflation and unemployment rate should be observed in detail.