Table of Content

1. Introduction 2

2. Literature Review 2

3. Economic Theory 3

4. Data and Motivation 5

4.1. Cointegration 5

5. Empirical Results 7

5.1. Stationarity Test 7

5.2. Optimal Length Selection 8

5.3. Johansen tests for cointegration 8

6. Conclusion 10

References 11

Appendix 12

Codes 14

**Validity of Phillips Curve**

# 1. Introduction

Unemployment and inflation, separately, have been two major topic of the macroeconomics. Researchers, therefore, tried hard to propose a theory in which the relationship between inflation and unemployment is identified. The Phillips Curve was a tool to accomplish this task in an easy and innovative way.

Philips curve has been on the agenda of economists in that it enables researcher to forecast inflation and properly implement monetary policy. Even though original 1958 Phillips Curve has undergone several modifications to date, it attracts considerable attention of both academics and practitioners.

In this study, validity of the Phillips Curve in Turkey between 09/2005-12/2017 is discussed in terms of theoretical background and empirical validity. In selecting the data, data availability is the primary factor.

The remainder of the study is as follows. In the second part of this study, literature review about the Phillips Curve is provided in a way to cover all the major contribution to the relationship between unemployment and inflation. In the third part of the study, theory behind the Phillips curve is presented so that we are able to build a sound empirical model. Because, as is known, successful empirical application should have proper theoretical background. In this part, the Phillips Curve is introduced and discussed in detail. In the fourth part, the data used in the empirical application and the motivation to conduct such a study is discussed. In the fifth part, empirical application is run and results are provided as well as its interpretation. In this part, it is decided whether or not the Phillips Curve holds in Turkey. In the final part concludes.

# 2. Literature Review

A. W. Phillips (1958) present the first empirical analysis about the association between nominal wage inflation and unemployment rate. To him, this relationship is negative. Since then, Phillips curve has been a hot topic especially in economics and various researchers have made significant contribution. Samuelson and Solow (1960) they revisit the Phillips Curve in a way to include price inflation rather than the nominal wage inflation. Besides, they proposed a combination of unemployment and inflation rates for policy makers.

As of 1960s, Keynesian approach to Phillips Curve stood out. Keynesian economists consider the Phillips Curve as a a menu of tradeoffs for policy-makers: They could use demand management policies to increase output and decrease unemployment, but this could only be done at the expense of higher inflation. However this approach wac critized harshly by Edmund Phelps (1967) and Milton Friedman (1968) in that Keynesian model based on the idea that low unemployment could be sustained by allowing high inflation but they put that empirical analysis suggests higher inflation without the sustainable low unemployment. Stagflation occured in 1970s backed this ideas as well as ruled out the original Phillips Curve.

Friedman and Phelps pointed out that the Phillips curve trade-off in the short run arises from the inability of economic agents to adjust their expectations to anticipated inflation level quickly. This is kind of expectation augmented-Phillips Curve and called as Monetarist Phillips Curve.

Then New Keynesian Approach came to the stage producing an expectations-augmented Phillips curve and gives micro foundations to the idea that overall price level adjusts slowly to changing economic conditions, are viewed as a dynamic extension of the static new Keynesian models of price adjustment (Kustepeli, 2005:582). According to the New Keynesian Approach, there might be an inflation-unemployment trade-off in the short run, under the assumption of rational expectation.

# 3. Economic Theory

In this part, the empirical model and the model which is considered best fit to this model is introduce. Before proceeding, it is worthwile presenting the original Phillips Curve exhibiting a persistent negative relationship between the changes in the wage inflation and the rate of unemployment.

**Figure-1: The Original Phillips Curve**

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**Source:** Bureau of Labor Statistics

In this part, theoretical background of the Phillips Curve is provided. Theory behind the Phillips Curve is easy: price of a commodity changes at a rate determined by excess demand for it. Labor market is chosen for this analysis due to the observable characteristics of the unemployment rate. So it is used as proxy for excess demand.

When there is excess demand in the labor market then it triggers a wage raise or vice versa. High level of excess demand in labor market leads to a change in wages which amounts to a decline in unemployment which in turn cause inflation.

In the case of equal supply and demand in the labor market, the unemployment will not be zero rather positive in that there exist some types of unemployment in an economy which is almost impossible to remove which are frictional and structural unemployment. These two types of unemployments are sometimes called natural unemployment. These two types of unemployments at the same time forms the non-accelerating inflation rate of unemployment (Nairu) a level of [unemployment](https://www.investopedia.com/terms/u/unemployment.asp) that is evident in an economy that does not cause [inflation](https://www.investopedia.com/terms/i/inflation.asp) to increase.

In this sense, Friedman and Phelps suggested more than one Phillips curve: Short run Phillips Curves and a long run Phillips Curve, which exists at the natural rate of unemployment (NRU). Indeed, in the long-run, there is no trade-off between unemployment and inflation.[[1]](#footnote-1)

# 4. Data and Motivation

Data, in this study, covers the period of 2005/09-2017/12. The inflation and unemployment data are monthly. Inflation data is reached by taking the percentage change of the Consumer Price Index (CPI, 2003=100) and gathered from the Central Bank of the Republic of Turkey. Also, unemployment data is collected from the Central Bank of the Republic of Turkey.

The primary motivation of this study is to explore one of the long-lasting unambiguous association between inflation and unemployment in that it is both important for policy makers and academic. Because many believe that Phillip Curve is a key measure of economic performance. Central bankers still extensively use Phillips Curve in policy making process.

Besides, despite its simplicity, there are some empirical evidences that Phillip Curve outperforms the rather complicated models. So it is at the same time beneficial tool for academics as well.

Empirically, our aim is to check whether there is a statistically significant relation between inflation and unemployment, it is of considerable importance to check stationarity of the variables. If we need to take first difference to make the variable stationary, then it is empirically better to apply cointegration to test whether regressions are trustworthy.

## 4.1. Cointegration

In the analysis of time series, a significant part of the data shows a non-stationary structure. Solving this problem is essential for a healthy regression analysis. One of the frequently used methods to solve this problem is to take first difference of the variable, but the most important drawback with this method is the loss of information. Because there are some relations that cannot be observed as the difference is taken. For example, when the first difference is taken the long-run relationship between the variables begins to disappear. Cointegration analysis is a search for a solution to this problem.

Cointegration analysis is an improved method to find out whether there is a long-term relationship between integrated time series in the same order. This method allows for the use of the original values of the series, which are not stationary in the level values but become stationary when the differences are taken from.

Firstly, our general model about cointegration between inflation and unemployment takes the form of:

Inft=a0+a1\*unempt+et

where inflation is the change in price index, unemp stands for the unemployment rate in Turkey and finally et is the disturbance term.

Depending on the result of the cointegration, vector error correction model (VECM) or vector autoregressive (VAR) model is used. In our case shown below, we could not confirm the cointegration so VAR model is used.

VAR system is an econometric tool to investigate the dynamic impact among the variables of the model for the following periods. In this method, endogenous variables in the system are treated as a function of the lagged values of all of the endogenous variables in the system. The basic VAR model has the form below;

yt=a1\*yt-1+…+apyt-p+et

where *y* is an observable endogenous variable, ai are fixed coefficient matrix, and et is an unobservable white noise process.

# 5. Empirical Results

In this part, empirical result and its interpretation is provided. Before moving to this part, descriptive statistics is given below. According to the descriptive statistics, mean of inflation and unemployment are 0.70 and 10.08, respectively. Standard deviation of inflation is 0.78 while unemployment has more fluctuation with 1.5 standard deviation.

Likewise, minimum and maximum values of inflation is lower than those of unemployment which is quite natural since the deviation of unemployment is higher.

**Table-1:** Descriptive Statistics

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Mean** | **Standard Deviation** | **Minimum** | **Maximum** |
| **Inflation** | .6999624 | .7804683 | -1.430743 | 3.272134 |
| **Unemployment** | 10.08716 | 1.504654 | 7.3 | 14.8 |
| **N** | 148 |  |  |  |

Pre-tests are important step of a regression analysis and stationarity test is one of them. Stationary among the variables is to be tested to specify the appropriate econometric model before the estimation procedure. Unit root tests determine whether series are stationary or not. The most widely used is the augmented Dickey-Fuller test (Makridakis et al., 1998:329).

## 5.1. Stationarity Test

Before starting the empirical analysis, stationarity test, augmented Dickey-Fuller (ADF), is applied. Results are provided below. According to the ADF test result, unemployment is not stationary (p-value is 0.2162) then first difference of unemployment is taken which makes the data stationary. Unlike the unemployment variable, inflation is stationary with p-value of 0.01

To sum up, it reveals that unemployment is non-stationary but after taking difference it become stationary. Inflation variable, on the other hand, is stationary.

**Table-2:** ADF Test Result-Unemployment

|  |  |  |
| --- | --- | --- |
|  | **P-value** | **P-value**  **(after differencing)** |
| Unemployment | 0.2162 | 0.0000 |

**Table-3:** ADF Test Result-Inflation

|  |  |
| --- | --- |
|  | **P-value** |
| Inflation | 0.01 |

## 5.2. Optimal Length Selection

One of the most important step in VAR application is to determine the optimal lag length. According to Braun and Mittnik (1993) if a VAR’s lag length differs from the true lag length then impulse response functions[[2]](#footnote-2) and variance decompositions derived from the estimated VAR. Optimal length selection table is provided below and it shows that optimal length is 6 according to the Schwarz criterion which is applied in our empirical analysis.

**Table-4:** Optimal Length Selection

|  |  |  |  |
| --- | --- | --- | --- |
| **AIC** | **HQ** | **SC** | **FPE** |
| **10** | **10** | **6** | **10** |

## 5.3. Johansen tests for cointegration

This test for cointegration makes it possible to estimate all cointegrating vectors when there are more than two variables. The null hypothesis of *r*=0 means that there is no cointegration at all. A rank *r*>0 implies a cointegrating relationship between two or possibly more time series.

Test statistics of 43.7201 reject the null hypothesis that there is cointegration. So, we can proceed with Vector autoregressive model.

Below given Table provides us the results of the VAR application. As the optimal length is 6, lag lengths are provided up to 6 lags. The equation of the VAR application is as follows:

inflation = inflation.L1 + d\_unemp.L1 + inflation.L2 + d\_unemp.l2 + inflation.L3 + d\_unemp.L3 + inflation.L4 + d\_unemp.L4 + constant + trend

L denotes the lag. For instance, L1 is the first lag. d represents the difference of the variable in question.

Results reveal that there is negative and statistically significant relation between unemployment and inflation which confirms the Phillips Curve in Turkey. The estimated coefficient of sixth lag unemployment is statistically significant at 10% level. To interpret, 1-point increase in unemployment decreases inflation by 0.40 point.

One of the most striking result is that other than the sixth lag of unemployment, no statistically significant relation is detected between inflation and unemployment. Moreover, all the estimated coefficients of unemployment are positive except for the fifth lag of unemployment.

**Table-5:** VAR Application Result

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Estimate** | **Std. Error** | **t-test** | **p-value** |
| **inf\_arrange.l1** | 0.11321 | 0.08643 | 1.310 | 0.19262 |
| **diff\_unemp.l1** | 0.11403 | 0.17924 | 0.636 | 0.52580 |
| **inf\_arrange.l2** | -0.18199 | 0.08601 | -2.116 | 0.03628 \* |
| **diff\_unemp.l2** | 0.13781 | 0.22646 | 0.609 | 0.54391 |
| **inf\_arrange.l3** | 0.10890 | 0.08414 | 1.294 | 0.19793 |
| **diff\_unemp.l4** | 0.01734 | 0.21724 | 0.080 | 0.93650 |
| **inf\_arrange.l4** | -0.22713 | 0.08439 | -2.691 | 0.00807 \*\* |
| **diff\_unemp.l4** | 0.27064 | 0.21829 | 1.240 | 0.21731 |
| **inf\_arrange.l5** | 0.02299 | 0.08555 | 0.269 | 0.78860 |
| **diff\_unemp.l5** | -0.03072 | 0.22847 | -0.134 | 0.89324 |
| **inf\_arrange.l6** | 0.15599 | 0.08557 | 1.823 | 0.07065 |
| **diff\_unemp.l6** | -0.40876 | 0.18163 | -2.251 | 0.02612 \* |
| **constant** | 0.69761 | 0.16356 | 4.265 | 3.85e-05 \*\*\* |

# 6. Conclusion

In this study, validity of the Philips Curve is checked in Turkey. To do that first, literature as well as theoretical background of the Phillips Curve is provided and then data used and motivation are given.

In the empirical part of the study, stationarity is checked and after defining the optimal lag length, cointegration is run to see whether data is cointegrated. As no cointegration detected, Vector Autoregressive model is applied with sixth lag length. It turns out that unemployment is negative correlated with inflation at 10% level of significance. This result confirms that th Phillips Curve is still valid in Turkey. However, We would like to emphasize that no statistically significant and negative relation is found between the inflation and unemployment other than the sixth lag length. So the result should be treated with caution.

# References

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# Appendix

**Figure-2:** Inflation

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**Figure-3:** Unemployment

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**Figure-4:** Differenced Unemployment

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# Codes

date<-seq(as.Date("2005/09/1"), by = "month", length.out = 148)

inf<-Validity\_of\_the\_phillips\_curve$`Price Index\_monthly change`

unemp<-Validity\_of\_the\_phillips\_curve$`Unemployment rate`

data<-Validity\_of\_the\_phillips\_curve

adf.test(unemp)

adf.test(inf)

diff\_unemp<-diff(unemp,lag=1)

inf\_arrange<-inf[-1]

modelIm<-lm(inf\_arrange ~ diff\_unemp, data =Validity\_of\_the\_phillips\_curve)

summary(modelIm)

data\_new<-data.frame(inf\_arrange,diff\_unemp)

VARselect(data,lag.max=10, type="both")

jo<-ca.jo(data.frame(inf\_arrange,diff\_unemp), type="trace", K=10, ecdet="none", spec="longrun")

summary(jo)

var<-VAR(data\_new, p=6, type="const")

summary(var)

1. http://www.economicsonline.co.uk/Global\_economics/Phillips\_curve.html [↑](#footnote-ref-1)
2. Impulse response functions are useful for studying the interactions between variables in a vector autoregressive model (Lütkepohl, 2008:1) [↑](#footnote-ref-2)