Data Exercise 2 - Shalem Sumanthiran

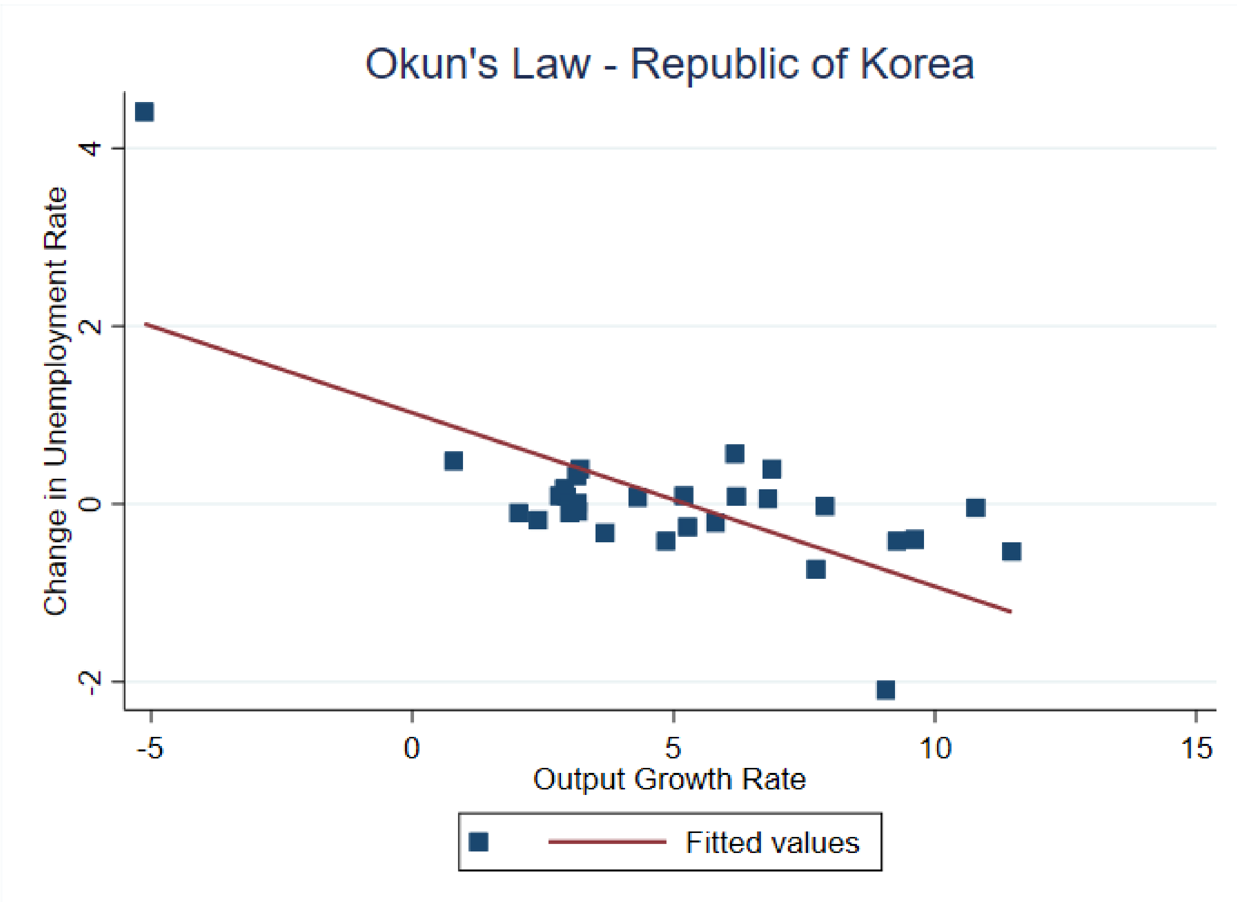
Data

All data was retrieved from FRED:

Title and Label	**Units**	**Frequency**
Real GDP - Real GDP at Constant National Prices for Republic of Korea - FRED Label RGDPNAKRA666NRUG	Millions of 2017 U.S. Dollars	Annual
GDP Deflator - Gross Domestic Product Deflator for Republic of Korea - FRED Label NGDPDSAIXKRQ	Index, Seasonally Adjusted	Annual
CPI - Consumer Price Index: All Items for Korea - FRED Label KORCPIALLMINMEI	Index 2015=100	Annual, Average
CPIQ4- Consumer Price Index: All Items for Korea - FRED Label KORCPIALLMINMEI	Index 2015=100	Annual, End of Period
Employment - Employed Population: Aged 15 and Over: All Persons for the Republic of Korea - FRED Label LFEMTTTTKRM647S	Persons, Seasonally Adjusted	Annual
K - Capital Stock at Constant National Prices for Republic of Korea - FRED Label RKNANPKRA666NRUG	Millions of 2017 U.S. Dollars	Annual
Money Supply - M1 for the Republic of Korea - FRED Label MANMM101KRM189S	National Currency, Seasonally Adjusted	Annual
POIL - Sport Crude Oil Price: West Texas	Dollars per Barrel	Annual

Intermediate (WTI) - FRED Label WTISPLC		
Unemployment Rate - Unemployment Rate: Aged 15 and Over: All Persons for the Republic of Korea - FRED Label LRUNTTTTKRM156S	Percent	Annual

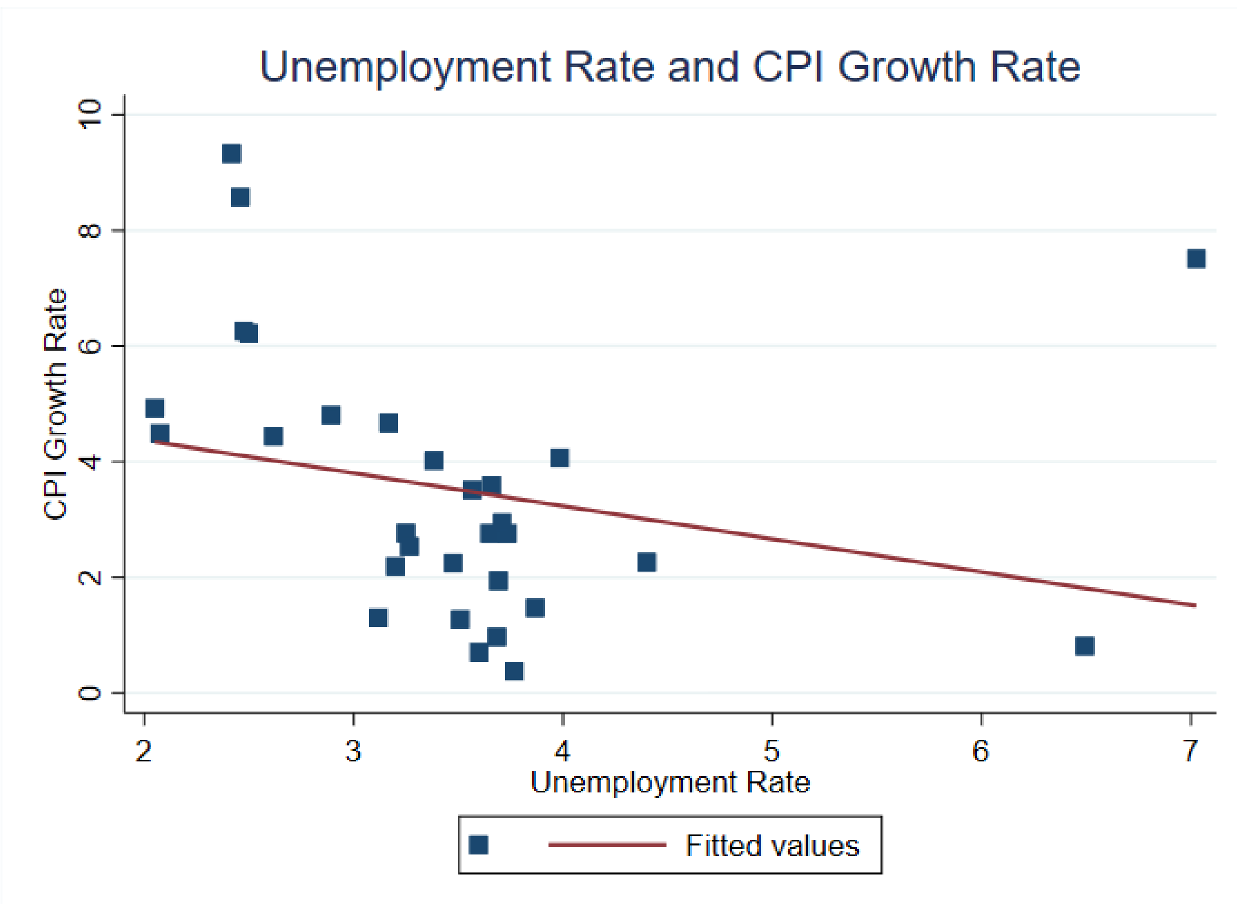
Question 1



To obtain these parameters, we generate a new variable of output growth rate using the following equation: gr(RGDP) = (RGDP[_n]-RGDP[_n-1])/RGDP[_n-1]*100, and similarly generate a new variable of change in unemployment rate with the following: Change in Unemployment Rate = (Unemployment Rate[_n]-Unemployment Rate[_n-1]). Through this we get the following parameters: slope of -.195211, constant of 1.024. This implies that on average, an increase in the growth rate of 1% decreases the unemployment rate by roughly 0.2%. The line crosses the horizontal axis at the point where annual growth rate is roughly 5%, which implies that it takes an annual growth rate of about 5% to keep unemployment constant.

When comparing this to the US parameters of a slope of -0.3 and constant of 2, we can see that the slope is roughly similar, but Korea requires a higher GDP growth rate to keep unemployment constant. This may be because Korea has an aging population which leads to a smaller labor force and makes it hard to keep creating new jobs and keep unemployment low. It may also be because of relatively greater structural rigidity in the Korean labor market, which makes it difficult for companies to adjust to changes in demand and leads to higher unemployment during economic downturns.

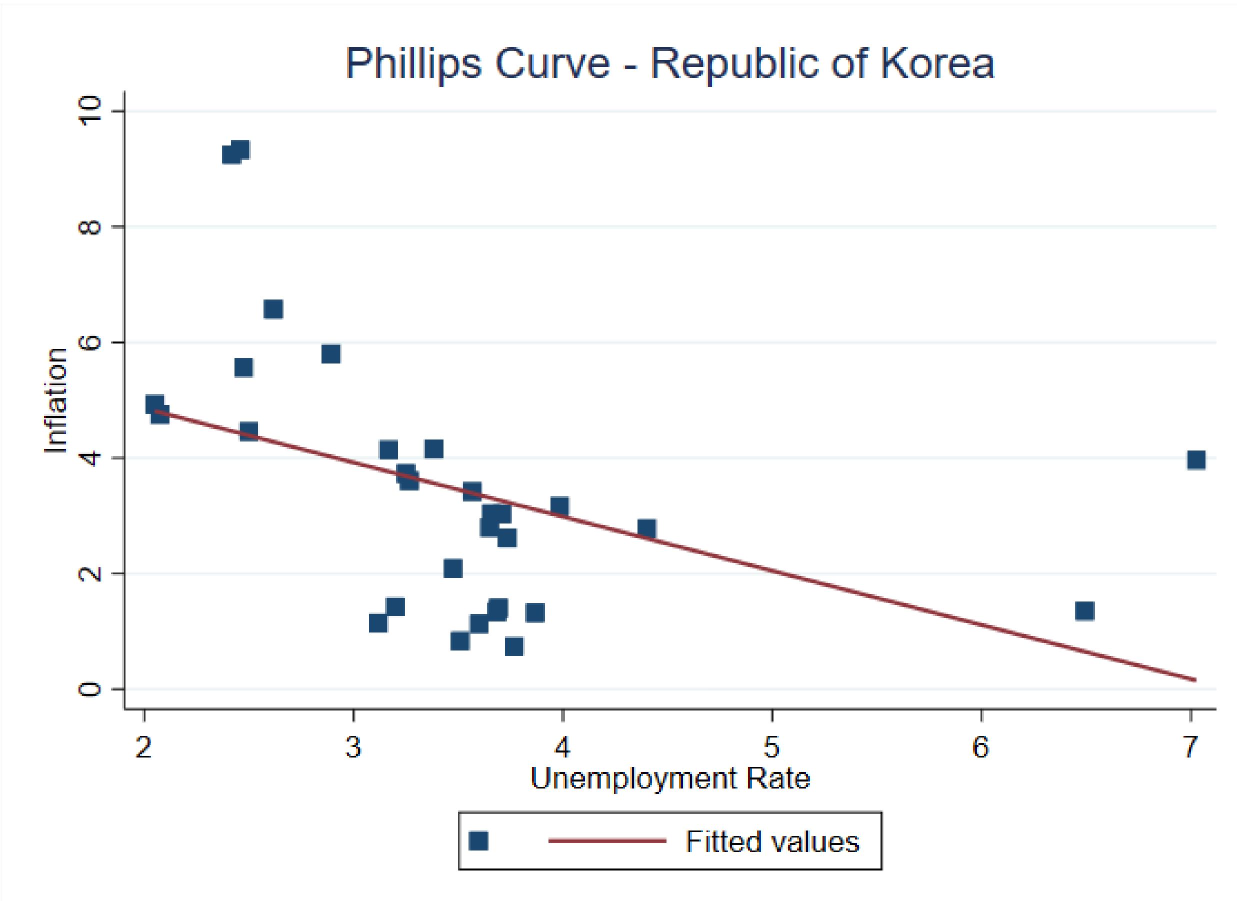
Question 2



For this scatter plot, we use the raw data for unemployment rate given that it takes the average over 4 quarters, and calculate growth rate of CPI using the following formula: gr(CPI) = (CPI[_n]-CPI[_n-1])/CPI[_n-1]*100

Question 3

$\pi_t = \beta_0 + \beta_1 UR_t$ Where UR=Unemployment Rate. We use the end of period CPI data which takes the 4th quarter to define Inflation as follows: grCPI = (CPI[_n]-CPI[_n-1])/CPI[_n-1]*100 After running the regression, we get the following equation: $\pi_t = 6.732 - 0.936UR_t$, where all coefficients are statistically significant with p-values below 0.05 and an R-squared of 0.19.



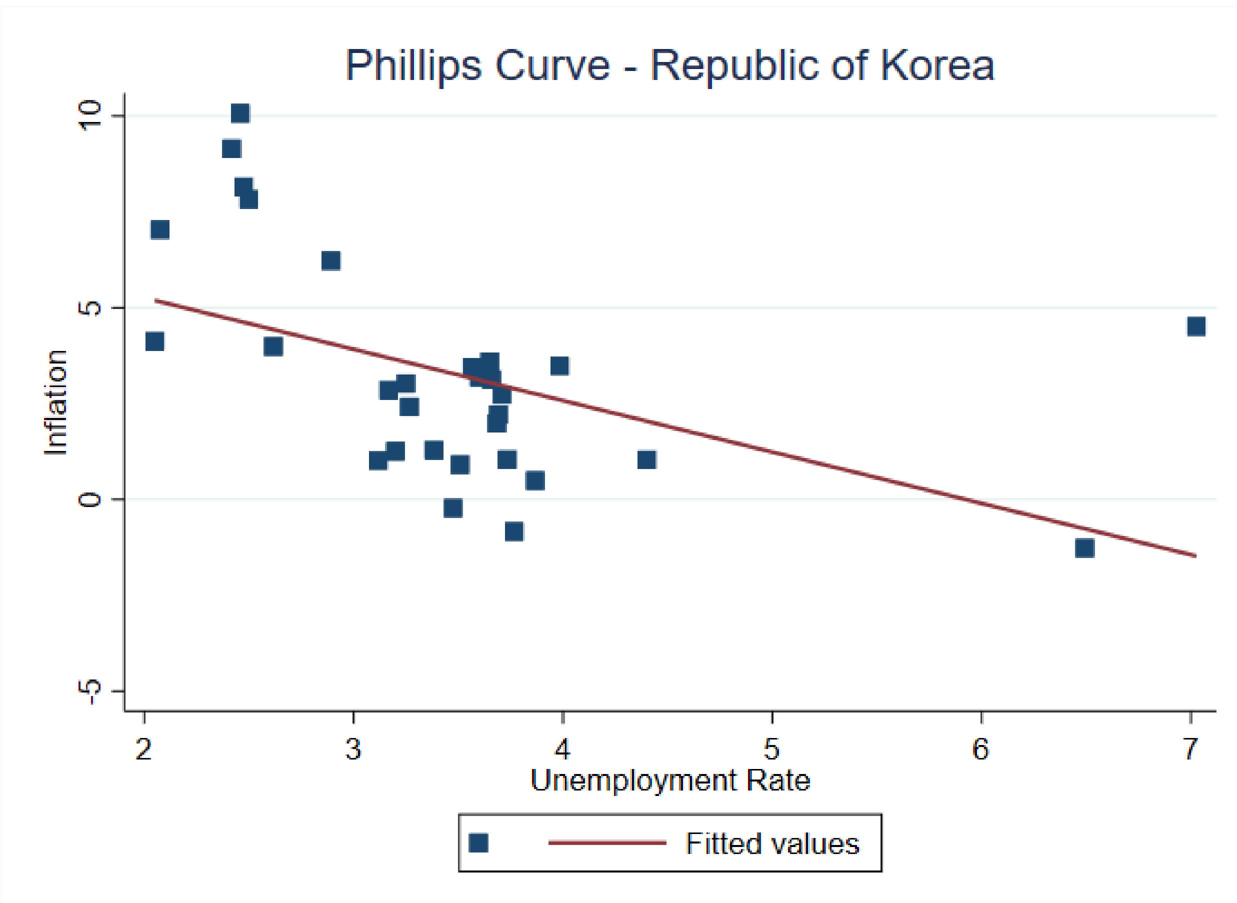
The estimated β_1 is -0.9, which is the expected sign, as it follows the Phillips curve which indicates that lower unemployment is associated with higher inflation. We can tell that if we want the unemployment rate to be around 3%, the inflation rate should be about 4%.

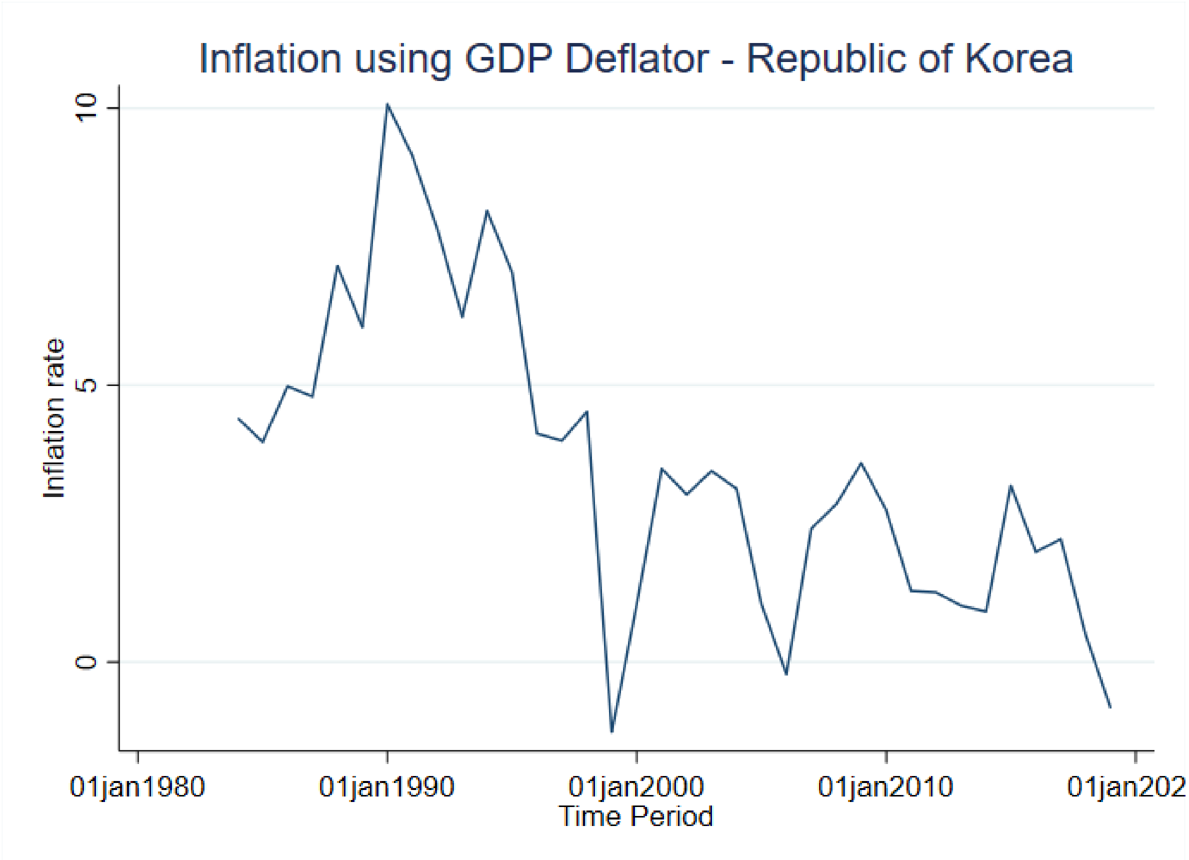
The Correlation coefficient is -0.4469, which is also somewhat expected as it follows that there is a relatively strong negative relationship between inflation and unemployment.

Question 4

Here we get the following equation using the same formulas as question 3 but replacing CPI with the GDP Deflator: $\pi_t = 7.939 - 1.34UR_t$, with all coefficients being statistically significant with p-values below 0.01 and an R-squared of 0.25

The estimated β_1 is -1.34, which is expected to be negative for the same reasons as in question 3, and the Correlation coefficient is -0.4949, which is also expected.



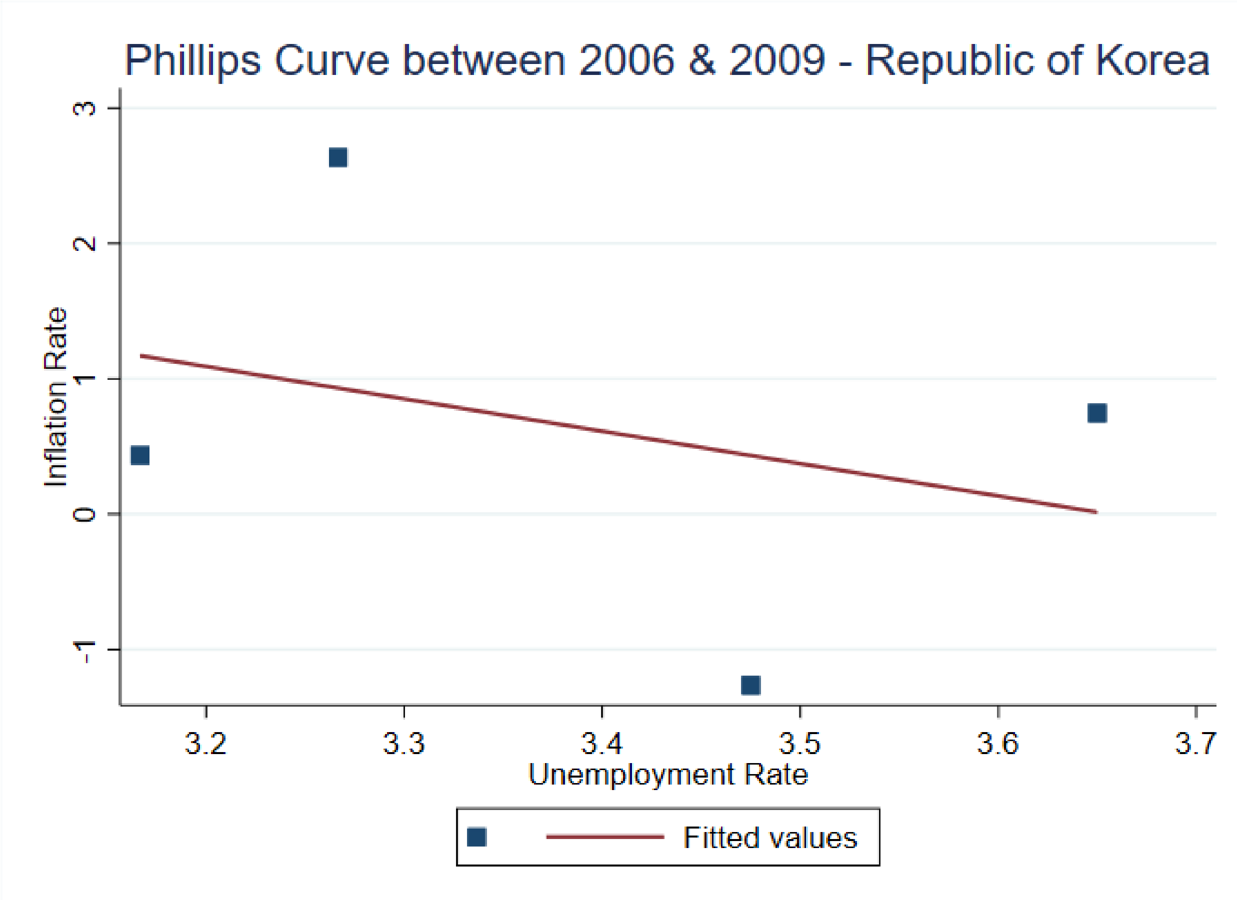


Question 5

From the above graph and the data, we can see that a period where the inflation rate is going up is 2006 to 2009. Although these only have 4 data using annual data, we can still compare the two equations. After running the regression we get the following equation:

$\pi_t - \pi_{t-1} = 8.75 - 2.39UR_t$ For this regression the R-squared is 0.1, with statistically insignificant coefficients as both p-values are above 0.6. However, if we were to run the same regression without calculating the difference in inflation rates, we get the following equation:

$\pi_t = 2.513 - 0.105UR_t$ However, here the R-squared value is 0.0002 and the p-values for the coefficients are both above 0.9, therefore we can conclude that using the difference in inflation rate is preferable as a model, but suffers from lack of data points. The graph below shows the Phillips curve for the first model:



Question 6

For the following regression, we take the difference in oil prices from the previous year to use the equation $\pi_t = \beta_0 + \beta_1 UR_t + \beta_2 \Delta POIL_t$ After running the regression, we get the following regression line: $\pi_t = 8.03 - 1.35UR_t - 0.35\Delta POIL_t$

Here we can conclude that the coefficient for unemployment rate has the expected sign, as we expect a negative relationship between unemployment rate and inflation rate, however the change in oil prices coefficient is negative. However, the P-value of β_2 is 0.3, which indicates that it is insignificant and therefore should not be considered, as compared to the other coefficients which are statistically significant with a p-value below 0.01.. When considering the explanatory power of change in oil prices, the R-squared value in the model without change in oil prices was 0.25, however the R-squared in the model with change in oil prices was 0.28. The difference is 0.03, which indicates a very small explanatory power of the inclusion of oil prices.

Question 7

To estimate the regression model

$\pi_t = \beta_0 + \beta_1 UR_t + \beta_2 \Delta POIL_t + \beta_3 \Delta MONEY_t + \beta_4 \Delta MONEY_{t-1}$, we find the change in M1 by subtracting by the previous year, as well as a time-lag change in M1 by shifting each observation by one year, creating a variable that is the change in M1 from the previous year. Running this regression we get the following values:

$$\pi_t = 9.03 - 1.22UR_t - 0.086\Delta POIL_t - 5.5\Delta MONEY_t + 7.01\Delta MONEY_{t-1}$$

Where all coefficients are statistically significant except the time lag change in M1. However there is a statistically significant negative relationship between money supply and inflation, which is unexpected as usually an increase in money supply might mean an increase in the inflation rate. As the units of M1 are in Korean Won, where 1 Korean Won=0.00075 in today's exchange rate, the effect is small. A possible explanation for this may be that the money supply was used to invest in productivity-enhancing activities such as infrastructure, education, and research and development, which can lead to increased output and improved efficiency in the long run, reducing the cost of production and lowering prices.

The R-squared for this model is 0.45, which is far greater than the previous 0.28, so we can conclude a large explanatory power of the inclusion of money growth in this model.

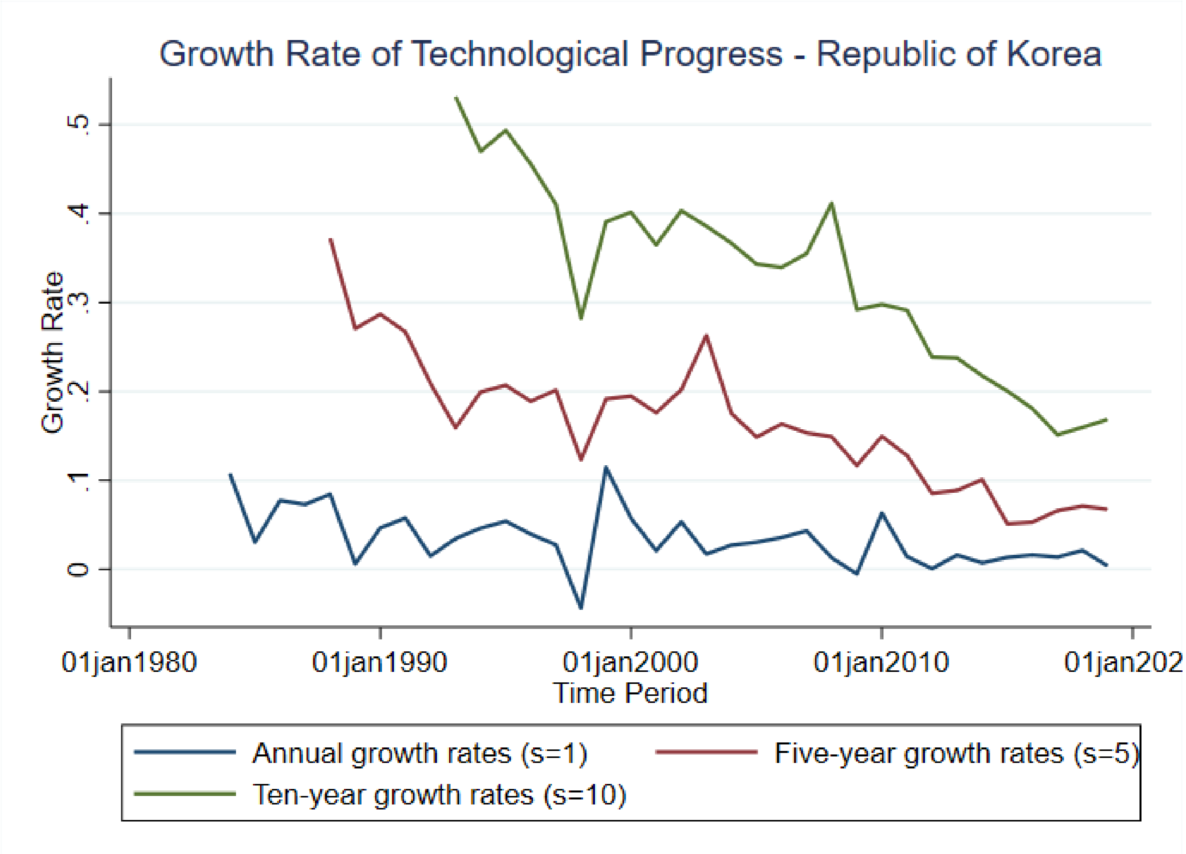
Question 8

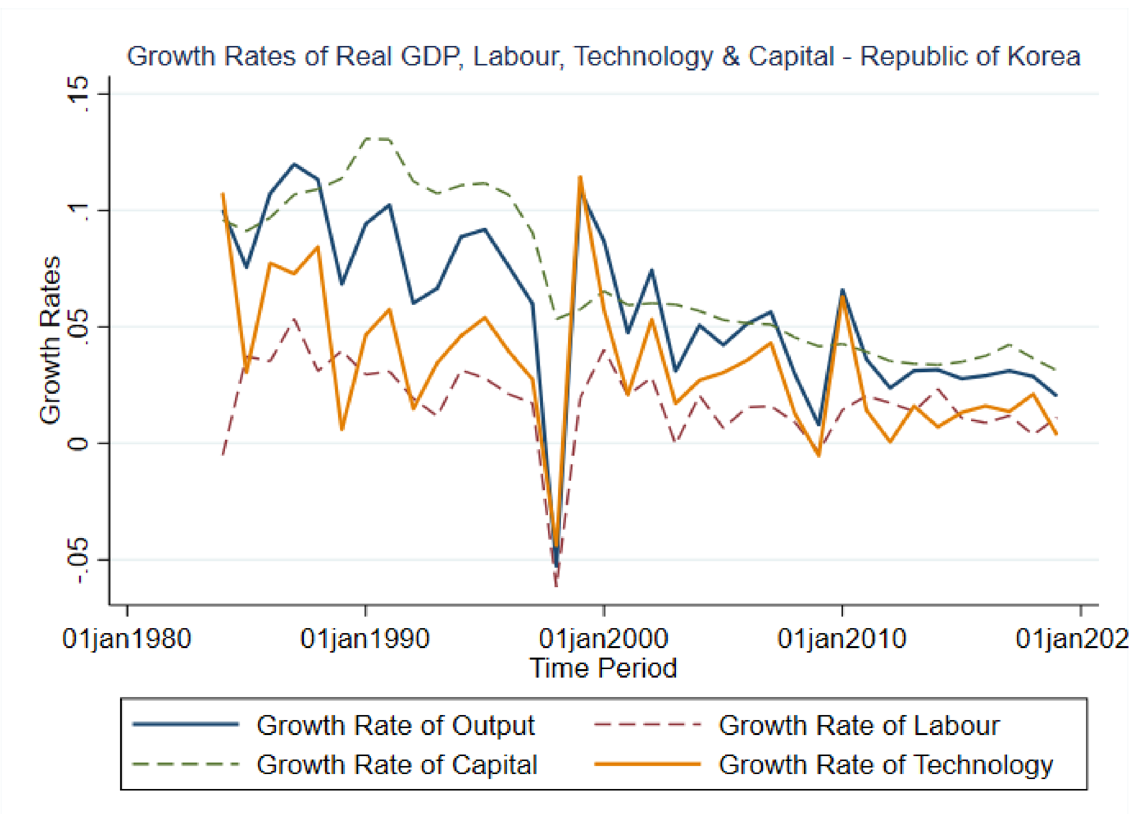
8.1

To find the difference in the growth rate of technical progress, we use the following equation:

$$(log(A_t) - log(A_{t-s}) = \frac{(log(Yt)-log(Yt-s)- 1/3(log(Kt)-log(Kt-s)-2/3(log(Lt)-log(Lt-s)}{2/3}$$

We get the following graphs when substituting s=1, s=5 and s=10


Growth Rate of Technological Progress - Republic of Korea
Growth Rate
0
.1
.2
.3
.4
.5
01jan1980
01jan1990
01jan2000
01jan2010
01jan202
Time Period
Annual growth rates (s=1)
Five-year growth rates (s=5)
Ten-year growth rates (s=10)


Growth Rates of Real GDP, Labour, Technology & Capital - Republic of Korea
Growth Rates
-.05
0
.05
.1
.15
01jan1980
01jan1990
01jan2000
01jan2010
01jan202
Time Period
Growth Rate of Output
Growth Rate of Labour
Growth Rate of Capital
Growth Rate of Technology

8.2

From the above graph we can identify a long run trend of cycles in the growth rate of output, most likely generated by technology as can be seen when comparing the graphs of all three components, where the trend lines of output growth and technology growth have been highlighted to indicate the similarities in trends.

8.3

First we calculate the total growth of each component by summing the difference in growth over the whole time period. After by using the equation, we obtain the following percentages for each component of growth:

Fraction of total growth accounted for by Capital = Total growth of capital*0.333/Total growth of Output

= (2.535936 * 0.33333)/2.082568 = 0.40589481 = **40.5%**

Fraction of total growth accounted for by Labour= Total growth of labor*0.333/Total growth of Output

= (.6262665 * 0.66667)/2.082568 = 0.20047993 = **20%**

Fraction of total growth accounted for by Technology= Total growth of technology*0.333/Total growth of Output

= (1.229621 * 0.66667)/2.082568 = 0.39362529 = **39.5%**

8.4

Technological growth rate can be negative if there is a decrease in productivity due to a decline in the rate of technological progress. In the instance of Korea, there are several possible explanations, such as excessive regulations by the government which might hinder innovation, a high income-inequality in Korea which could mean a lack of skilled workers to contribute to technological progress, or lack of funding or direct investment directed towards research and development, which limits the scope of technological progress.