

# SWEDEN

**Group Assignment BEMACS**  
**Econometrics 30413**

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# ANALYSIS' STRUCTURE

- ❑ Phillips Curve with monthly data from Jan. 1983 to Dec. 2020
- ❑ Phillips Curve – yearly data from 1983 – 2019
- ❑ Expanded model with interest rates
- ❑ Expanded model with average wages
- ❑ Linear Regression
- ❑ Significance Testing
- ❑ Testing Homoskedasticity
  - >>> Breusch-Pagan Test
- ❑ Testing Serial correlation
  - >>> Breusch-Godfrey Test
- ❑ Plots
  - >>> Residual vs. Fitted
  - >>> Normal Q-Q
  - >>> Scale Location
  - >>> Residuals vs. Leverage

The R script and the data are available at the following [GitHub Repo](#)

# PHILLIPS CURVE —

## MONTHLY DATA FROM JAN. 1983 TO DEC. 2020

The Phillips curve depicts the relationship between the rate of inflation rate and unemployment rate.

Residuals:

Min	1Q	Median	3Q	Max
-3.403	-1.318	-0.593	1.194	6.757

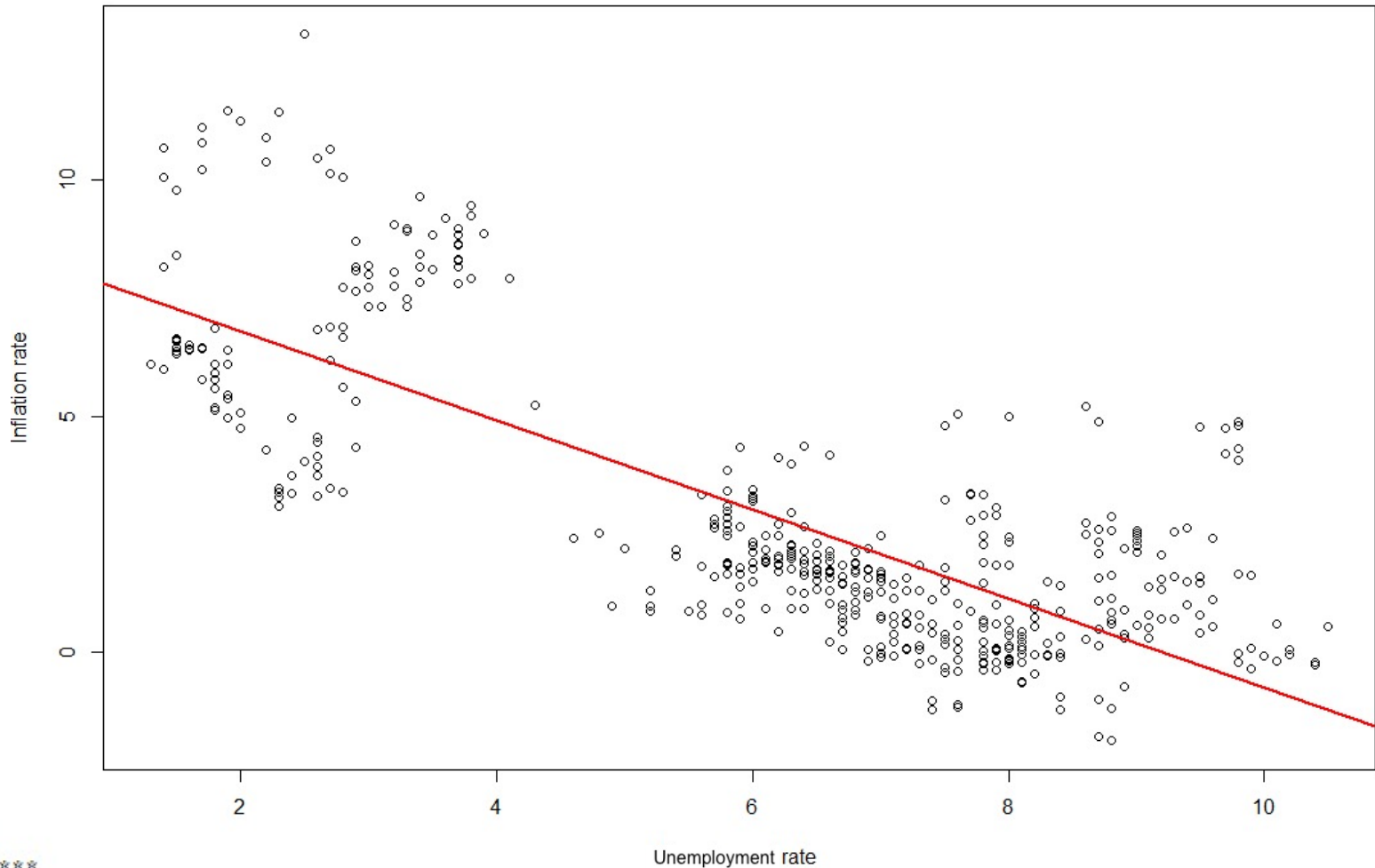
Coefficients:

	Estimate	Std. Error	t value	Pr(> t )	
(Intercept)	8.67787	0.24915	34.83	<2e-16	***
unemp_monthly\$value	-0.94183	0.03699	-25.46	<2e-16	***

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signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.893 on 454 degrees of freedom  
Multiple R-squared: 0.5881, Adjusted R-squared: 0.5872  
F-statistic: 648.3 on 1 and 454 DF, p-value: < 2.2e-16



## Testing Homoskedasticity:

studentized Breusch-Pagan test

```
data: pc_monthly
BP = 19.636, df = 1, p-value = 9.367e-06
```

## Heteroskedasticity-robust standard errors:

```
> coeftest(pc_monthly, vcov=hccm)
```

t test of coefficients:

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	8.677872	0.322219	26.932	< 2.2e-16 ***
unemp_monthly\$value	-0.941828	0.045731	-20.595	< 2.2e-16 ***

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Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

## Testing Serial Correlation:

Breusch-Godfrey test for serial correlation of order up to 1

```
data: pc_monthly
LM test = 408.71, df = 1, p-value < 2.2e-16
```

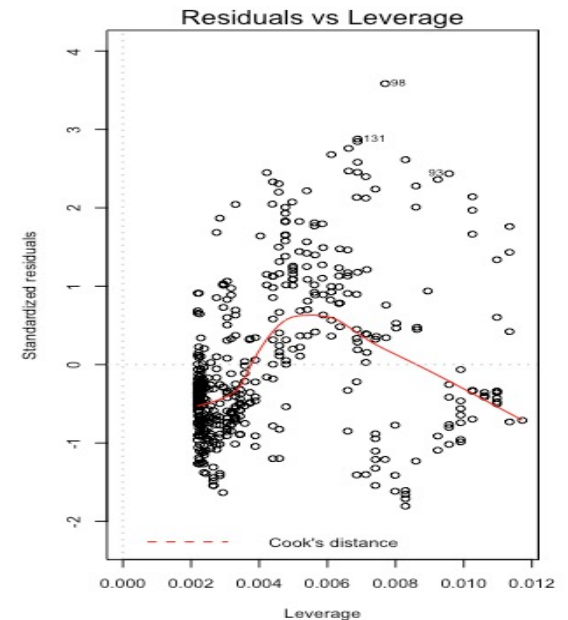
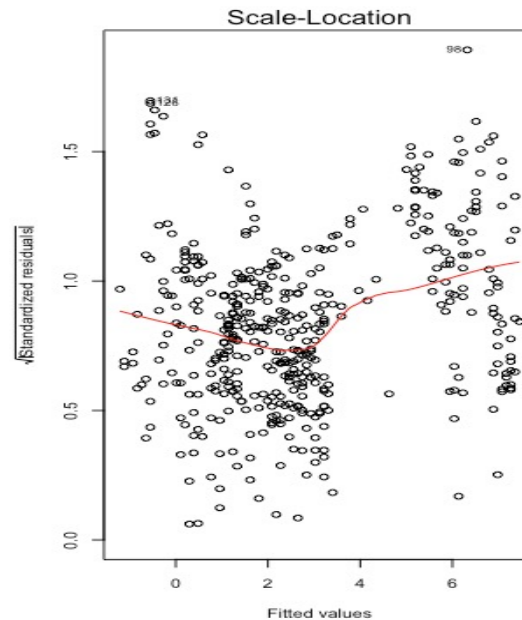
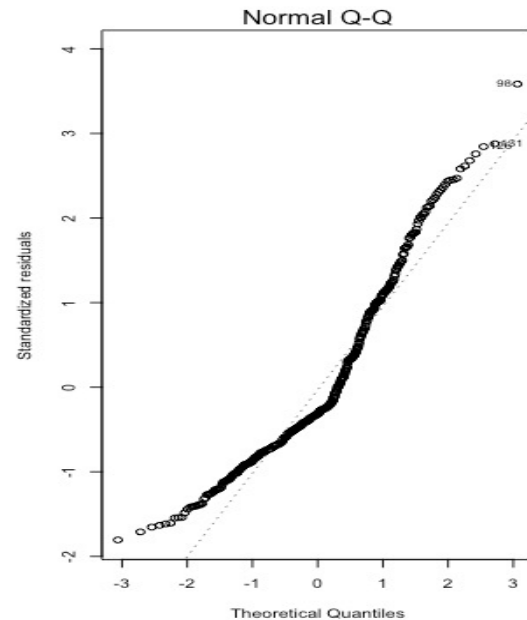
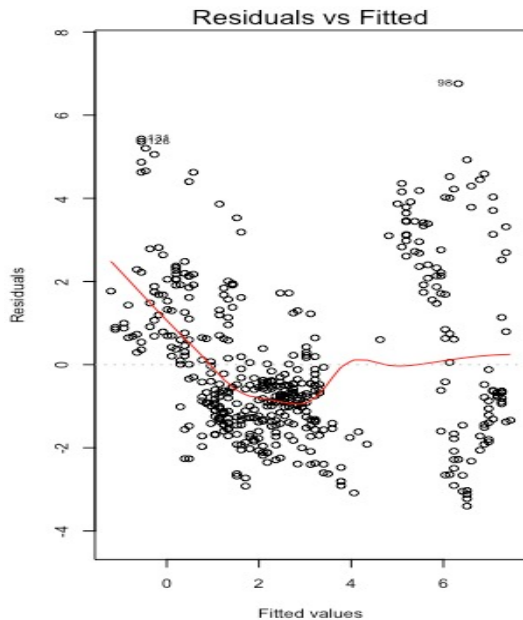
## HAC-robust standard errors:

```
> coeftest(pc_monthly, vcov=vcovHAC)
```

t test of coefficients:

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	8.67787	0.66863	12.9785	< 2.2e-16 ***
unemp_monthly\$value	-0.94183	0.10888	-8.6501	< 2.2e-16 ***

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Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1



# ANALYSIS

- ❑ Based on the initial regression model, unemployment is statistically significant.
- ❑ However, after running diagnostic tests on our model, the model fails both the Breusch-Pagan and Breusch-Godfrey tests.
- ❑ Running the model, testing for HAC-robust standard errors and Homoskedasticity-robust standard errors, shows the estimates do not differ much from the standard regression model and thus we can be confident in them.
- ❑ This is in line with the well accepted economic theory of the Phillips curve.

# PHILLIPS CURVE — YEARLY DATA FROM 1983 - 2019

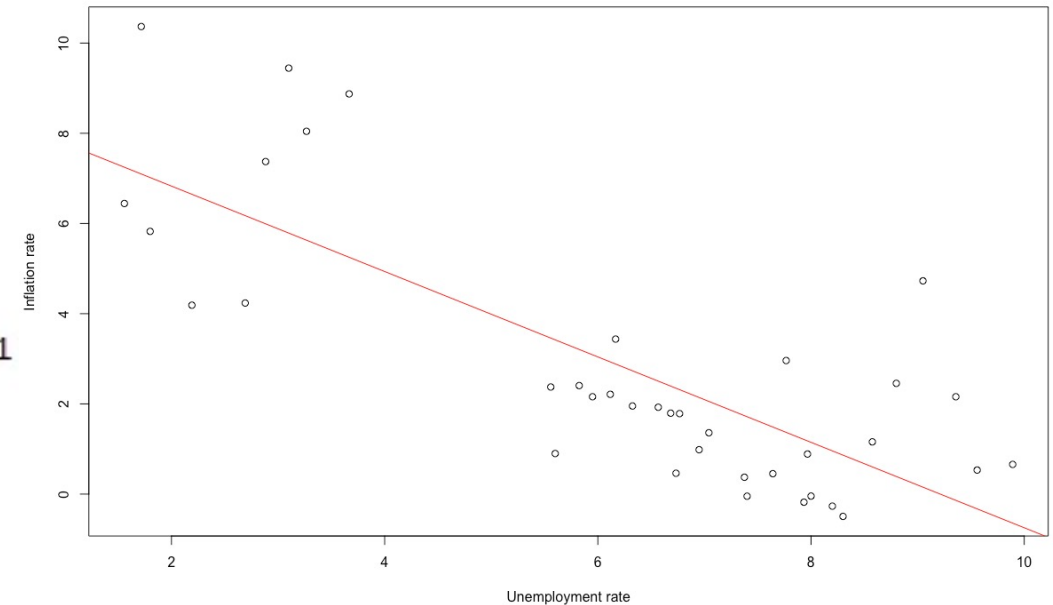
In our expanded Phillips Curve model, we will use the basic Phillips Curve model with yearly data from 1983 to 2019 as our control.

The yearly model has the following output (which is in line with our monthly model):

```
Residuals:
    Min       1Q   Median       3Q      Max
-2.5174 -1.1930 -0.7147  1.3091  4.5812

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)    8.7237     0.8638   10.099 6.55e-12 ***
unemp$value   -0.9477     0.1293   -7.328 1.45e-08 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.868 on 35 degrees of freedom
Multiple R-squared:  0.6054,    Adjusted R-squared:  0.5941
F-statistic: 53.7 on 1 and 35 DF,  p-value: 1.449e-08
```



# EXPANDED MODEL WITH INTEREST RATES

The model can be adjusted by adding short-term and long-term interest rates as explanatory variables.

```
Residuals:
    Min       1Q   Median       3Q      Max
-3.7286 -0.6664 -0.2032  0.7572  2.9044

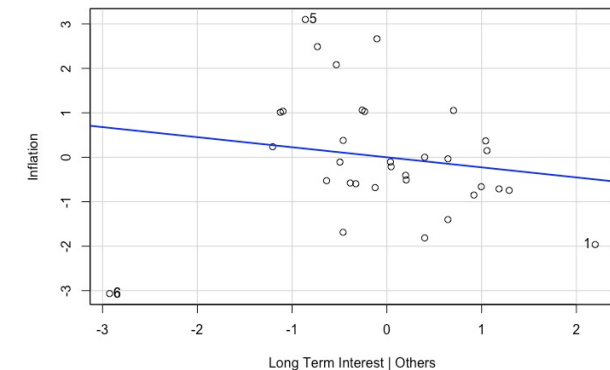
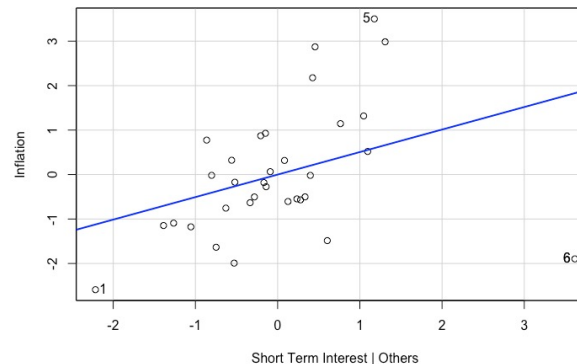
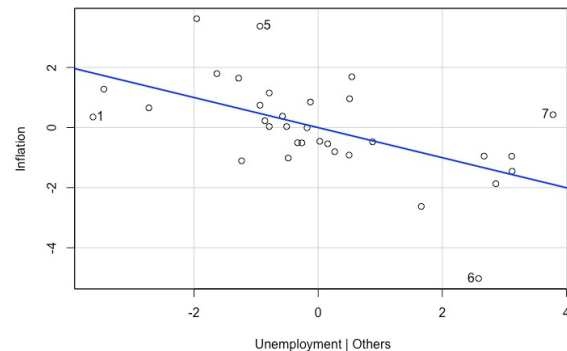
Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)      4.6390      1.1270   4.116 0.000292 ***
unemp_adjusted$value -0.5007      0.1354  -3.699 0.000900 ***
st_int_adjusted$value  0.5067      0.2430   2.086 0.045920 *
lt_int$value      -0.2265      0.2595  -0.873 0.389930
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.402 on 29 degrees of freedom
Multiple R-squared:  0.733,    Adjusted R-squared:  0.7054
F-statistic: 26.54 on 3 and 29 DF,  p-value: 1.843e-08
```

Evaluating the explanatory variables independently, the results of the t-test show long-term interest rates are statistically insignificant. But, based on the joint F-test results, the explanatory variables are jointly statistically significant.

This follows the economic theories behind interest rates and inflation; the model shows, when interest rates increase, inflation follows.

## Partial Regression Plots:





## Testing Homoskedasticity:

studentized Breusch-Pagan test

data: pc\_1  
BP = 21.113, df = 3, p-value = 9.972e-05

## Heteroskedasticity-robust standard errors:

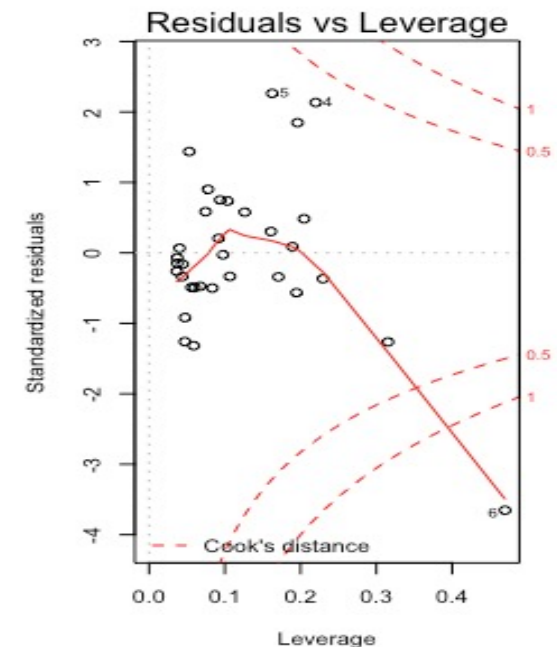
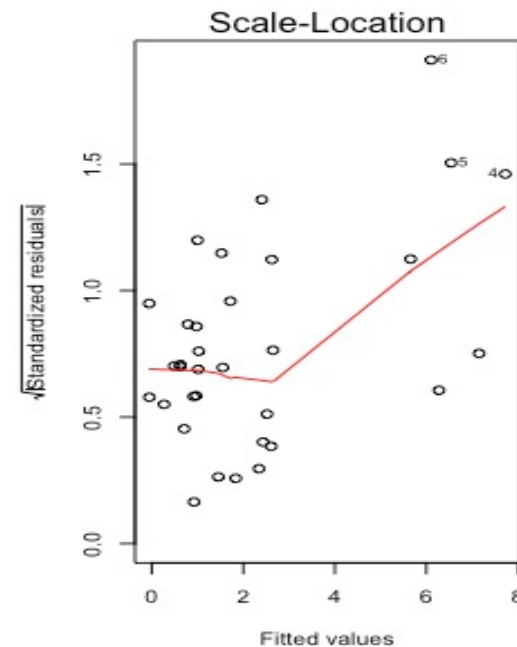
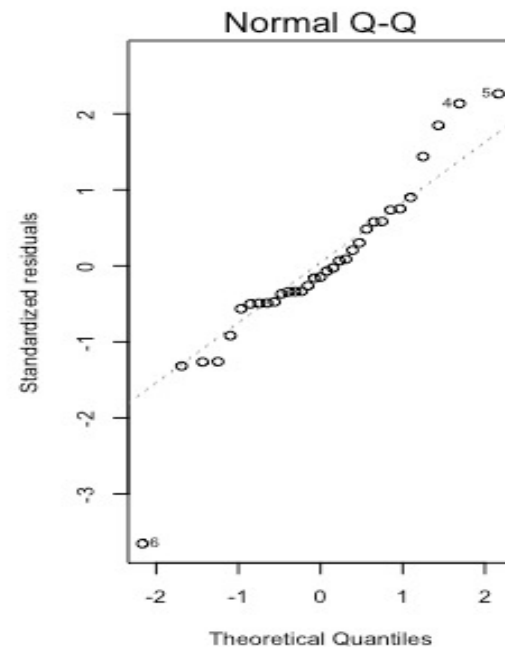
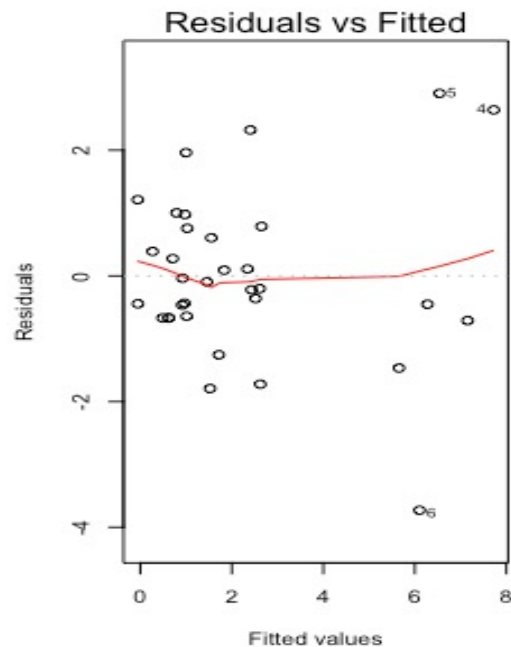
	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	4.63901	1.12592	4.1202	0.0002884 ***
unemp_adjusted\$value	-0.50072	0.22985	-2.1785	0.0376443 *
st_int_adjusted\$value	0.50672	0.80090	0.6327	0.5318936
lt_int\$value	-0.22647	0.74111	-0.3056	0.7621091

---  
signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

## Testing Serial Correlation:

Breusch-Godfrey test for serial correlation of order up to 1

data: pc\_1  
LM test = 0.10759, df = 1, p-value = 0.7429





# EXPANDED MODEL WITH AVERAGE WAGES

This is the original model with average wages as an explanatory variable.

Residuals:

Min	1Q	Median	3Q	Max
-2.8849	-0.8938	-0.1747	0.8972	3.2044

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	1.421e+01	1.951e+00	7.281	7.86e-08 ***
unemp_adjusted_2\$value	-9.362e-01	1.624e-01	-5.764	3.95e-06 ***
avg_wages\$value	-1.502e-04	4.478e-05	-3.354	0.00237 **

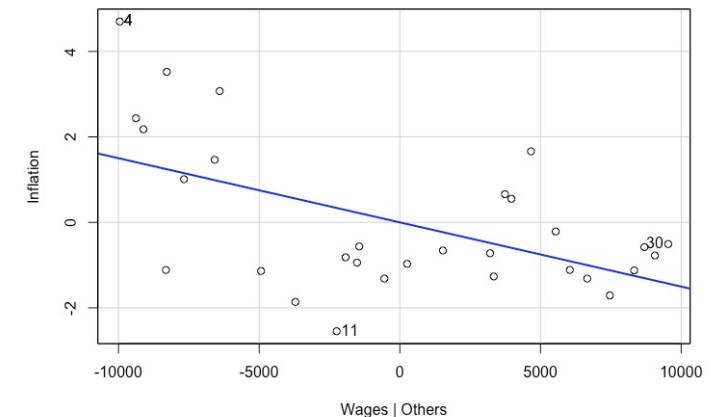
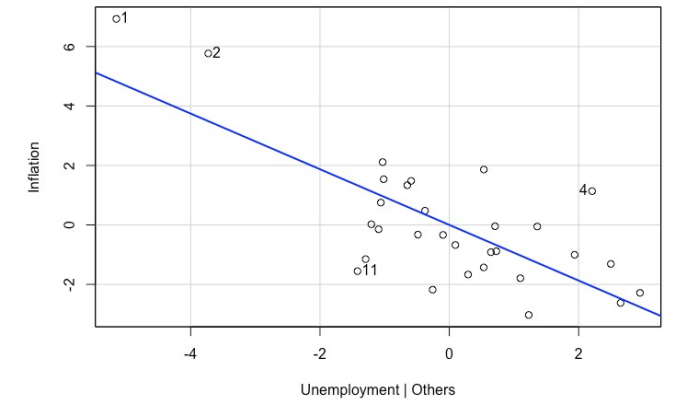
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signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.527 on 27 degrees of freedom

Multiple R-squared: 0.644, Adjusted R-squared: 0.6176

F-statistic: 24.42 on 2 and 27 DF, p-value: 8.808e-07



## Testing Homoskedasticity:

studentized Breusch-Pagan test

data: pc\_2  
BP = 9.1487, df = 2, p-value = 0.01031

## Testing Serial Correlation:

Breusch-Godfrey test for serial correlation of order up to 1

data: pc\_2  
LM test = 2.5367, df = 1, p-value = 0.1112

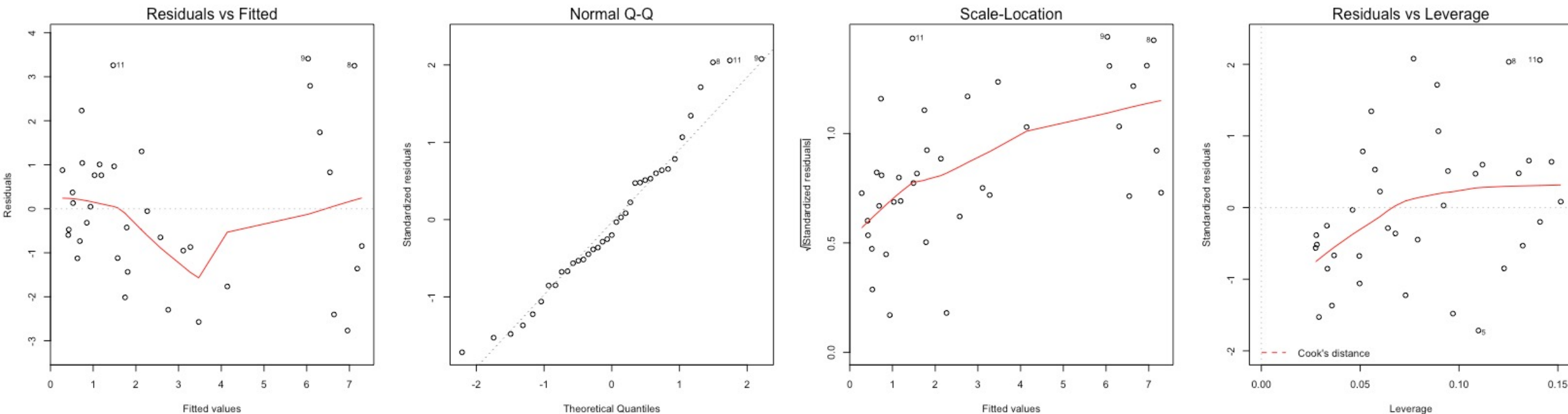
## Heteroskedasticity-robust standard errors:

```
> coeftest(pc_2, vcov=hccm)
```

t test of coefficients:

	Estimate	Std. Error	t value	Pr(> t )	
(Intercept)	1.4207e+01	3.3848e+00	4.1972	0.0002622	***
unemp_adjusted_2\$value	-9.3622e-01	2.7548e-01	-3.3985	0.0021184	**
avg_wages\$value	-1.5020e-04	5.4348e-05	-2.7637	0.0101666	*

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signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1



# ANALYSIS

## Model Specifications

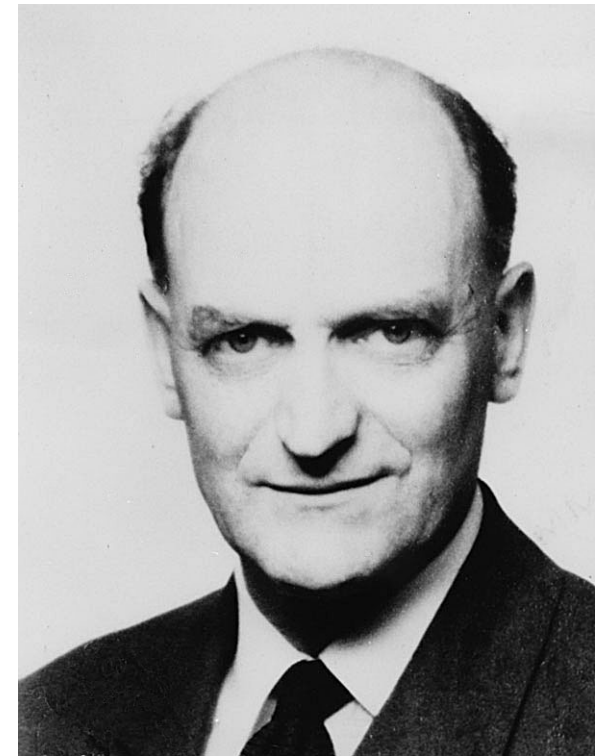
The three models we evaluated were the standard Phillips curve, then the Phillips curve with short-term and long-term interest rates added, and finally the Phillips curve with average wages. The results of the model consistently showed unemployment has an inverse relationship with inflation and is statistically significant. The model with short-term and long-term interest rates added showed the best relationship between the variables even though it failed the homoskedasticity tests.

# ANALYSIS

## Relevant economic hypotheses

A Phillips curve describes the inverse relation between inflation and unemployment. The Phillips curve was developed by A. W. Phillips who stated inflation and unemployment have a stable and inverse relationship. The theory states with economic growth comes inflation, which in turn should lead to more jobs and less unemployment.

The relationship between interest rates and inflation is inverse. Central Banks use interest rates to control inflation. When interest rates are low businesses and individuals demand more money, in the form of loans. This leads to an increase in money being spent in an economy which increases prices. When interest rates are high there is a smaller demand for money so less money is spent and prices remain the same.



# SOURCES & BIBLIOGRAPHY

All the data used are taken from:

- <https://data.oecd.org/sweden.htm>