Chapter 11 - Further Issues in Using OLS with Time Series Data

Thalles Quinaglia Liduares

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Exercise 11.11

Upload packages

```
library(wooldridge)
library(lmreg)
library(car)
```

Upload database

```
data<-wooldridge::okun

attach(data)
```

Okun's Law—see, for example, Mankiw (1994, Chapter 2)—implies the following relationship between the annual percentage change in real GDP, `pcrgdp`, and the change in the annual unemployment rate, `cunem`:

$$pcrgdp = 3 - 2 \cdot cunem$$

If the unemployment rate is stable, real GDP grows at 3% annually. For each percentage point increase in the unemployment rate, real GDP grows by two percentage points less. (This should not be interpreted in any causal sense; it is more like a statistical description.)

(i) Use the data in OKUN.RAW to estimate the equation. Do you get exactly 3 for the intercept and -2 for the slope? Did you expect to?

```
summary(lm1<-lm(pcrgdp~cunem))
```

```
##
## Call:
## lm(formula = pcrgdp ~ cunem)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.52079 -0.84443 -0.02261  0.87194  1.94649
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   3.3444     0.1627   20.56  < 2e-16 ***
## cunem        -1.8909     0.1820  -10.39 2.04e-13 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.103 on 44 degrees of freedom
##   (1 observation deleted due to missingness)
## Multiple R-squared:  0.7104, Adjusted R-squared:  0.7038
## F-statistic: 107.9 on 1 and 44 DF,  p-value: 2.037e-13
```

```
lm1$coefficients
```

```
## (Intercept)       cunem
##    3.344427   -1.890915
```

The estimated equation is expressed as follows

$$\widehat{pcrgdp}_t = 3.34 - 1.89 cunem_t$$

The estimated coefficients are almost equal to the effective values.

(ii) Find the t statistic for testing $H_0 : \beta_1 = -2$. Do you reject H_0 against the two-sided alternative at any reasonable significance level?

```
linearHypothesis(lm1, c("cunem=-2"))
```

```
## Linear hypothesis test
##
## Hypothesis:
## cunem = - 2
##
## Model 1: restricted model
## Model 2: pcrgdp ~ cunem
##
##   Res.Df    RSS Df Sum of Sq      F Pr(>F)
## 1     45 53.993
## 2     44 53.556  1   0.43715 0.3591 0.5521
```

Its not possible to reject the null hypothesis that $\beta_1 = -2$ at the 5% significance level.

iii. Find the t statistic for testing $H_0 : \beta_0 = 3$. Do you reject H_0 at the 5% level against the two-sided alternative? Is it a “strong” rejection?

```
linearHypothesis(lm1, c("(Intercept)=3"))
```

```
## Linear hypothesis test
##
## Hypothesis:
## (Intercept) = 3
##
## Model 1: restricted model
## Model 2: pcrgdp ~ cunem
##
##   Res.Df    RSS Df Sum of Sq      F  Pr(>F)
## 1     45 59.012
## 2     44 53.556  1    5.4565 4.4829 0.03992 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

In this case, it's possible to reject the null hypothesis at the 5% level of statistical significance.

(iv) Find the F statistic and p-value for testing $H_0 : \beta_0 = 3, \beta_1 = -2$ against the alternative that H_0 is false. Does the test reject at the 10% level? Overall, would you say the data reject or tend to support Okun's Law?

```
linearHypothesis(lm1,c("cunem=-2", "(Intercept)=3"))
```

```
## Linear hypothesis test
##
## Hypothesis:
## cunem = - 2
## (Intercept) = 3
##
## Model 1: restricted model
## Model 2: pcrgdp ~ cunem
##
##   Res.Df    RSS Df Sum of Sq      F Pr(>F)
## 1     46 59.420
## 2     44 53.556  2    5.8641 2.4089 0.1017
```

Based in the p-value of F-Test, its not possible to reject the null hypothesis, so we do not support the Okun Law in this specific case.