

# In-Class Lab 8

*ECON 4223 (Prof. Tyler Ransom, U of Oklahoma)*

*February 12, 2019*

The purpose of this in-class lab is to practice conducting *joint* hypothesis tests of regression parameters in R. We will do this using t-tests and F-tests. The lab should be completed in your group. To get credit, upload your .R script to the appropriate place on Canvas.

## For starters

Open up a new R script (named ICL8\_XYZ.R, where XYZ are your initials) and add the usual “preamble” to the top:

```
# Add names of group members HERE
library(tidyverse)
library(broom)
library(wooldridge)
library(car)
library(magrittr)
```

## Load the data

We’ll use a data set on earnings and ability, called `htv`. The data set contains a sample of 1,230 workers.

```
df <- as_tibble(htv)
```

Check out what’s in the data by typing

```
glimpse(df)
```

The main variables we’re interested in are: `wages`, `education`, `ability`, `parental education`, and `region` of residence (`ne`, `nc`, `west`, and `south`).

## Create regional factor variable

Let’s start by creating a factor variable from the four regional dummies. Borrowing code from lab 6, we have:

```
df %<>% mutate(region = case_when(ne==1 ~ "Northeast",
                                   nc==1 ~ "NorthCentral",
                                   west==1 ~ "West",
                                   south==1 ~ "South")) %>%
  mutate(region = factor(region))
```

## Regression and Hypothesis Testing

Estimate the following regression model:

$$educ = \beta_0 + \beta_1 motheduc + \beta_2 fatheduc + \beta_3 abil + \beta_4 abil^2 + \beta_5 region + u$$

Note that *abil* is in standard deviation units. You will need to use a `mutate()` function to create *abil*<sup>2</sup> (not shown here). Call it *abilsq*. *region* represents the factor variable you created above.<sup>1</sup>

```
est <- lm(educ ~ motheduc + fatheduc + abil + abilsq + region, data=df)
tidy(est)
```

## t-test

1. Test the hypothesis that *abil* has a linear effect on *educ*.

## F-test (single parameter)

2. Now test that *motheduc* and *fatheduc* have equal effects on *educ*. In other words, test  $H_0 : \beta_1 = \beta_2$ ;  $H_a : \beta_1 \neq \beta_2$ . To do this, you will need to obtain  $se(\beta_1 - \beta_2)$ . Luckily, R will do this for you with the `linearHypothesis()` function in the *car* package:

```
linearHypothesis(est, "motheduc = fatheduc")
```

The resulting p-value is that of an F test, but one would get an identical result by using a t-test, since this is a simple hypothesis (see Wooldridge (2015), pp. 125-126).

## F-test (multiple parameters)

The p-values from the previous regression might indicate that the three region dummies don't contribute to education.

3. Test the hypothesis that they don't; i.e. test

$$H_0 : \text{all region dummies} = 0; H_a : \text{any region dummy} \neq 0$$

The code to do this again comes from the `linearHypothesis()` function. The syntax is to enclose each component hypothesis in quotes and then surround them with `c()`, which is how R creates vectors.

```
linearHypothesis(est, c("regionNortheast=0", "regionSouth=0", "regionWest =0"))
```

or, more simply,

```
linearHypothesis(est, matchCoefs(est, "region"))
```

Alternatively, you can perform the F-test as follows (no need to put this in your R-script; I'm just showing you how to do it "by hand"):

```
est.restrict <- lm(educ ~ motheduc + fatheduc + abil + abilsq, data=df)
Fstat.numerator <- (deviance(est.restrict)-deviance(est))/3
Fstat.denominator <- deviance(est)/1222
Fstat <- Fstat.numerator/Fstat.denominator
p.value <- 1-pf(Fstat,3,1222)
```

This gives the exact same answer as the `linearHypothesis()` code.

<sup>1</sup>Here the notation of  $\beta_5 \text{region}$  is not quite right. It more technically should be written  $\beta_5 \text{region.NE} + \beta_6 \text{region.S} + \beta_7 \text{region.W}$ , where each of the *region.X* variables is a dummy. The way it is written above,  $\beta_5 \text{region}$  implies that  $\beta_5$  is a vector, not a scalar.

## References

Wooldridge, Jeffrey M. 2015. *Introductory Econometrics: A Modern Approach*. 6th ed. Cengage Learning.