University of Nottingham
UK | CHINA | MALAYSIA

Autumn 2018

Econometric Theory I

Computer Lab Class II

Juergen Amann
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Wednesday 12:00 - 13:00, C42 SCGB

Last week

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$$\texttt{earnings}_\texttt{i} = \beta_1 + \beta_2\texttt{educ}_\texttt{i} + \beta_3\texttt{workexp}_\texttt{i} + u_i$$

where

  - $\texttt{earnings}_\texttt{i}$: earnings of individual *i* in USD per hour
  - $\texttt{educ}_\texttt{i}$: education of individual *i* as in years
  - $\texttt{workexp}_\texttt{i}$: work experience of individual *i* in years
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- We found `educ` and `workexp` to be highly significant and positive.

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  - Restricted Least Squares.

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- We want to know if there is a a significant difference in earnings between men and women **controlling for education and work experience**.

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        EDUC |   2.678125   .2336497    11.46   0.000     2.219146    3.137105
     WORKEXP |   .5624327   .1285136     4.38   0.000     .3099816    .8148837
       _cons |  -26.48501    4.27251    -6.20   0.000    -34.87789   -18.09213
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        EDUC |   2.591137   .2285497    11.34   0.000     2.142174      3.0401
     WORKEXP |   .4056773   .1288199     3.15   0.002     .1526236     .658731
      FEMALE |   -5.90905   1.113972    -5.30   0.000    -8.097337   -3.720764
       _cons |  -19.69195    4.36076    -4.52   0.000    -28.25822   -11.12567
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$$\widehat{earnings}_i = \begin{cases} (-19.69 - 5.91) + 2.59 * \texttt{educ} + 0.41 * \texttt{workexp} & \text{if } \texttt{female}_\texttt{i} = 1 \\ -19.69 \qquad\qquad\; + 2.59 * \texttt{educ} + 0.41 * \texttt{workexp} & \text{if } \texttt{female}_\texttt{i} = 0 \end{cases}$$

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- Structural stability in cross-section setting:
  - A different relationship exists for different cross-sectional groups, i.e. there is a significant difference in earnings between men and women.

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- The gender pay gap is bigger if we do **not** control for `educ` and `workexp`.
- This is what is meant when you hear *'The gender pay gap shrinks when we take into account ...'* in our case education and work experience.
- Also, there's more to the question than it seems! Let's take a look!

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- We estimate

$$\texttt{educ}_\texttt{i} = \beta_1 + \beta_2 \texttt{aptitude}_\texttt{i} + \beta_3 \texttt{mothereduc}_\texttt{i} + \beta_4 \texttt{fathereduc}_\texttt{i} + u_i$$

  where

  - $\texttt{educ}_\texttt{i}$: education of individual i in years
  - $\texttt{aptitude}_\texttt{i}$: test score of individual i attained on aptitude test
  - $\texttt{mothereduc}_\texttt{i}$: years i's mother spent in full-time education
  - $\texttt{fathereduc}_\texttt{i}$: years i's father spent in full-time education
  - u_i: idiosyncratic error of i.

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  MOTHEREDUC |   .0492425   .0390901     1.26   0.208     -.027546    .1260309
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- All coefficients are positive.
- Coefficient for `mothereduc` is insignificant.

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  - $H_0 : \beta_f - \beta_m = 0$, $H_a : \beta_f - \beta_m \neq 0$
- $F_{1,T-k-1} = \left(\frac{(\hat{\beta}_f - \hat{\beta}_m) - (\beta_f - \beta_m)}{\sqrt{se^2_{\beta_f} + se^2_{\beta_m} + 2 \times se_{\beta_f} se_{b_m}}} \right)^2, H_0 : \left(\frac{(\hat{\beta}_f - \hat{\beta}_m)}{\sqrt{se^2_{\beta_f} + se^2_{\beta_m} + 2 \times se_{\beta_f} se_{\beta_m}}} \right)^2$

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  - $se^2 = \hat{\sigma}^2$, the sample variance.
  - $\hat{\beta}_j$, the estimated coefficient.
  - As before: Observed Value – Value Predicted under H_0 (here equal to 0) divided by the estimated standard error of the estimator.

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. test MOTHEREDUC =  FATHEREDUC

 ( 1)  MOTHEREDUC - FATHEREDUC = 0

       F(  1,   536) =    0.90
            Prob > F =    0.3440
```

- We **fail** to reject H_0 as F-statistic is smaller than the critical value.
- Important: This is **not** a test of joint significance of both coefficients!
- You can also get the above F-statistic 'by hand'. See how it's done!

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  - $\texttt{educ}_\texttt{i} = \beta_1 + \beta_2\texttt{aptitude}_\texttt{i} + \beta_3\texttt{mothereduc}_\texttt{i} + \beta_4\texttt{fathereduc}_\texttt{i} + u_i$

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  - $\texttt{educ}_\texttt{i} = \beta_1 + \beta_2 \texttt{aptitude}_\texttt{i} + \beta_3 \texttt{mothereduc}_\texttt{i} + \beta_4 \texttt{fathereduc}_\texttt{i} + u_i$
  - If $\beta_3 = \beta_4$ then our model becomes:

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------------------------------------------------------------------------------
        EDUC |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    APTITUDE |   .1253106   .0098434    12.73   0.000     .1059743    .1446469
  PARENTSEDU |   .0828368   .0164247     5.04   0.000     .0505722    .1151014
       _cons |    5.29617   .4817972    10.99   0.000     4.349731    6.242608
------------------------------------------------------------------------------
```

Thank you and see you next week!

Juergen Amann

juergen.amann@nottingham.ac.uk
Wednesday 12:00 - 13:00, C42 SCGB

Exercise 1: Gender differences

Go back

In our data set men have (on average) higher education and more work experience:

```
. tabstat EARNINGS EDUC WORKEXP, stat(mean sd) long by(FEMALE)
```

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```
. tabstat EARNINGS EDUC WORKEXP, stat(mean sd) long by(FEMALE)

FEMALE      stats |  EARNINGS      EDUC   WORKEXP
------------------+------------------------------
0            mean |  23.11448  13.72222  17.87201
               sd |  16.05073  2.575381  3.993107
------------------+------------------------------
1            mean |  16.15796  13.62222   15.9287
               sd |  11.59666  2.297135  4.641399
------------------+------------------------------
Total        mean |  19.63622  13.67222  16.90036
               sd |  14.41566  2.438476  4.433377
-------------------------------------------------
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There is also notably more variation in earnings and work experience for men (check standard deviation).

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-------------------------------------------------
```

There is also notably more variation in earnings and work experience for men (check standard deviation).

Lastly, do the blue numbers look familiar? Compare them with the output when running

```
. regress EARNINGS FEMALE
```

Exercise 2: F-statistic 'by hand'

Go back

```
. regress EDUC APTITUDE MOTHEREDUC FATHEREDUC
```

Exercise 2: F-statistic 'by hand'

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```
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------------------------------------------------------------------------------
        EDUC |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    APTITUDE |   .1257087    .0098533    12.76   0.000     .1063528    .1450646
  MOTHEREDUC |   .0492425    .0390901     1.26   0.208     -.027546    .1260309
  FATHEREDUC |   .1076825    .0309522     3.48   0.001       .04688    .1684851
       _cons |   5.370631    .4882155    11.00   0.000      4.41158    6.329681
------------------------------------------------------------------------------
```

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------------------------------------------------------------------------------

. vce
```

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------------------------------------------------------------------------------

. vce

Covariance matrix of coefficients of regress model

        e(V) |   APTITUDE  MOTHEREDUC  FATHEREDUC       _cons
-------------+------------------------------------------------
    APTITUDE |  .00009709
  MOTHEREDUC | -.00008909   .00152803
  FATHEREDUC | -.00006315  -.00066072   .00095804
       _cons | -.00320754  -.00529709  -.00044575   .23835441
```

Remember under H_0 : $\left[(\hat{\beta}_f - \hat{\beta}_m) \times \left(\sqrt{se^2_{\beta_f} + se^2_{\beta_m} + 2 \times se_{\beta_f} se_{\beta_m}}\right)^{-1}\right]^2$

```
. display ((.0492425 - .1076825 ) / (sqrt(.00152803 + .00095804 +  2 * .00066072)))^2
.89697298 <- this is the F-statistic F( 1, 536) = 0.90!
```