MESTRADO EM

ECONOMETRIA APLICADA E PREVISÃO

MICROECONOMETRIA I

Aplicação Empírica: MÉTODOS CLÁSSICOS

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1. Instalação de packages úteis

```
ssc install rhausman
ssc install xttest3
ssc install xtscc
net install sg164_1, from(http://www.stata-journal.com/software/sj8-1)
```

2. Ler dados

```
use wagepan.dta, clear
```

2.1. Descrever a base de dados

```
describe
```

```
Contains data from wagepan.dta
  obs:         4,360
 vars:            44                          2 Apr 2002 22:39
 size:       222,360
-------------------------------------------------------------------------------
              storage  display     value
variable name   type   format      label      variable label
-------------------------------------------------------------------------------
nr              int    %9.0g                  person identifier
year            int    %9.0g                  1980 to 1987
agric           byte   %9.0g                  =1 if in agriculture
black           byte   %9.0g                  =1 if black
bus             byte   %9.0g                  =1 if business & repair serv.
construc        byte   %9.0g                  =1 if in construction
ent             byte   %9.0g                  =1 if entertainment
exper           byte   %9.0g                  labor mkt experience
fin             byte   %9.0g                  =1 if finance
hisp            byte   %9.0g                  =1 if Hispanic
poorhlth        byte   %9.0g                  =1 if in poor health
hours           int    %9.0g                  annual hours worked
                     (output longo omitido propositadamente)
-------------------------------------------------------------------------------
Sorted by: nr  year
```

2.2. Declara base de dados como painel

```
xtset nr year
       panel variable:  nr (strongly balanced)
        time variable:  year, 1980 to 1987
                delta:  1 unit
```

NOTA:

Primeira variável refere-se a "*i*", segunda variável refere-se a "*t*". Pode definir-se o painel de outras formas.

3. Estatística descritiva no contexto de painel

```
xtdescribe
      nr:  13, 17, ..., 12548                                n =        545
    year:  1980, 1981, ..., 1987                             T =          8
           Delta(year) = 1 unit
           Span(year)  = 8 periods
           (nr*year uniquely identifies each observation)

Distribution of T_i:   min      5%     25%       50%       75%     95%     max
                         8       8       8         8         8       8       8

     Freq.  Percent    Cum. |  Pattern
 ---------------------------+----------
      545    100.00  100.00 |  11111111
 ---------------------------+----------
      545    100.00         |  XXXXXXXX
```

xtsum lwage educ exper black hisp married union

```
Variable         |      Mean   Std. Dev.       Min        Max |    Observations
-----------------+--------------------------------------------+----------------
lwage    overall |  1.649147    .5326094  -3.579079    4.05186 |     N =    4360
         between |              .3907468   .3333435   3.174173 |     n =     545
         within  |              .3622636  -2.467201   3.204687 |     T =       8
                 |                                            |
educ     overall |  11.76697    1.746181          3         16 |     N =    4360
         between |              1.747585          3         16 |     n =     545
         within  |                     0   11.76697   11.76697 |     T =       8
                 |                                            |
exper    overall |  6.514679    2.825873          0         18 |     N =    4360
         between |              1.654918        3.5       14.5 |     n =     545
         within  |              2.291551   3.014679   10.01468 |     T =       8
                 |                                            |
black    overall |  .1155963    .3197769          0          1 |     N =    4360
         between |               .320034          0          1 |     n =     545
         within  |                     0   .1155963   .1155963 |     T =       8
                 |                                            |
hisp     overall |  .1559633    .3628622          0          1 |     N =    4360
         between |              .3631539          0          1 |     n =     545
         within  |                     0   .1559633   .1559633 |     T =       8
                 |                                            |
married  overall |  .4389908    .4963208          0          1 |     N =    4360
         between |              .3766116          0          1 |     n =     545
         within  |              .3236137  -.4360092   1.313991 |     T =       8
                 |                                            |
union    overall |  .2440367    .4295639          0          1 |     N =    4360
         between |              .3294467          0          1 |     n =     545
         within  |              .2759787  -.6309633   1.119037 |     T =       8
```

➔ Enfoque na variável `lwage`:

Overall – diz respeito a todos os indivíduos da amostra, ao longo do período em análise

```
sum lwage
```

```
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
       lwage |      4,360    1.649147    .5326094  -3.579079    4.05186
```

Between – médias no tempo dos indivíduos da amostra

```
bysort nr: egen lwage_mean_t=mean(lwage)
```

Within – observações expurgadas das dinâmicas temporais

```
egen lwage_mean_it=mean(lwage)
gen lwage_within=lwage-lwage_mean_t
gen lwage_within_comp=lwage-lwage_mean_t+lwage_mean_it
```

```
xtsum lwage
```

```
Variable         |      Mean   Std. Dev.       Min        Max |    Observations
-----------------+--------------------------------------------+----------------
lwage    overall |  1.649147    .5326094  -3.579079    4.05186 |     N =    4360
         between |              .3907468    .3333435   3.174173 |     n =     545
         within  |              .3622636  -2.467201   3.204687 |     T =       8
```

```
sum lwage lwage_mean_t lwage_within lwage_within_comp
```

```
    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
       lwage |      4,360    1.649147    .5326094  -3.579079    4.05186
lwage_mean_t |      4,360    1.649147    .3904329   .3333435   3.174173
lwage_within |      4,360    1.62e-09    .3622636  -4.116348    1.55554
lwage_with~p |      4,360    1.649147    .3622636  -2.467201   3.204687
```

<u>NOTA</u>:

O *Stata* procede a uma transformação "*within* comparável", de média não nula, o que torna a variável transformada comparável com a mesma variável após outras transformações.

```
xttab educ
```

	Overall		Between		Within
educ	Freq.	Percent	Freq.	Percent	Percent
3	8	0.18	1	0.18	100.00
5	16	0.37	2	0.37	100.00
6	40	0.92	5	0.92	100.00
7	16	0.37	2	0.37	100.00
8	144	3.30	18	3.30	100.00
9	136	3.12	17	3.12	100.00
10	376	8.62	47	8.62	100.00
11	736	16.88	92	16.88	100.00
12	1848	42.39	231	42.39	100.00
13	432	9.91	54	9.91	100.00
14	328	7.52	41	7.52	100.00
15	248	5.69	31	5.69	100.00
16	32	0.73	4	0.73	100.00
Total	4360	100.00	545	100.00	100.00
			(n = 545)		

```
xttab married
```

	Overall		Between		Within
married	Freq.	Percent	Freq.	Percent	Percent
0	2446	56.10	472	86.61	64.78
1	1914	43.90	383	70.28	62.47
Total	4360	100.00	855	156.88	63.74
			(n = 545)		

➔ Para `married==1:`

Overall – número de indivíduos que estiveram casados, em toda a amostra

Between – número de indivíduos que alguma vez estiveram casados ao longo do período amostral (o *Total Between* é diferente do total da amostra porque existem indivíduos que mudaram de estado civil ao longo do período amostral)

Within percent – fracção de tempo, em média, que um indivíduo permaneceu casado

Total Within – fracção de tempo, em média, que um indivíduo não mudou de estado civil

xttrans married

```
     =1 if |      =1 if married
   married |         0          1 |     Total
-----------+----------------------+----------
         0 |     86.05      13.95 |    100.00
         1 |      4.94      95.06 |    100.00
-----------+----------------------+----------
     Total |     52.48      47.52 |    100.00
```

<u>INTERPRETAÇÃO:</u> 95.06% dos indivíduos que eram casados permaneceram casados no período seguinte. 86.05% dos indivíduos que eram não casados permaneceram não casados no período seguinte. 13.95% dos indivíduos que eram não casados passaram a ser casados no período seguinte. 4.94% dos indivíduos que eram casados passaram a ser não casados no período seguinte.

➔ Os valores do comando **xttrans** são iguais aos do comando **xttab** se considerarmos a dinâmica subjacente (é necessário retirar uma observação temporal no comando **xttab**, uma vez que o comando **xttrans** considera as mudanças de estado entre *t* e *t*-1):

xttrans married

```
     =1 if |      =1 if married
   married |         0          1 |     Total
-----------+----------------------+----------
         0 |     86.05      13.95 |    100.00
         1 |      4.94      95.06 |    100.00
-----------+----------------------+----------
     Total |     52.48      47.52 |    100.00
```

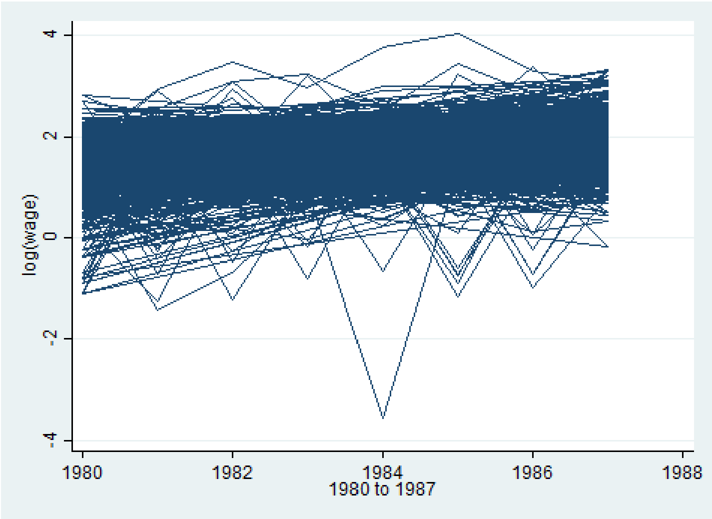
xttab married if year>=1981

```
                  Overall             Between            Within
  married |    Freq.  Percent      Freq.  Percent        Percent
----------+-----------------------------------------------------
        0 |     2002     52.48       421     77.25         67.93
        1 |     1813     47.52       382     70.09         67.80
----------+-----------------------------------------------------
    Total |     3815    100.00       803    147.34         67.87
                                  (n = 545)
```

4. Gráficos

4.1. Todos os indivíduos num só gráfico

```
line lwage year
```



4.2. Um gráfico por indivíduo (todos na mesma escala)

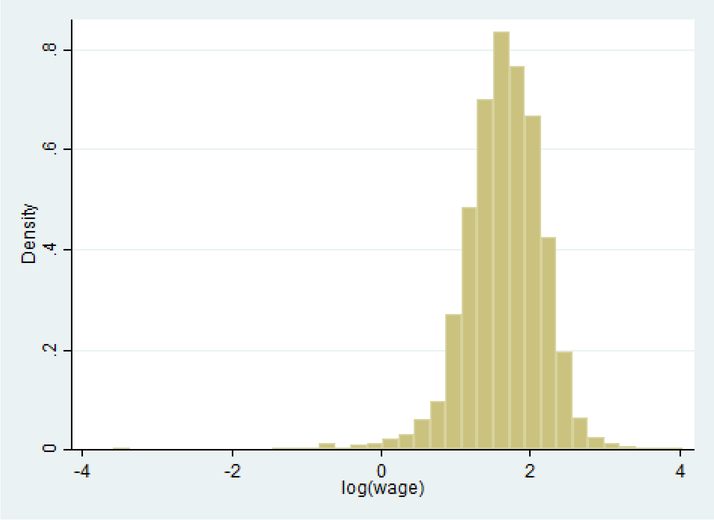
```
xtline lwage if nr<=100
```

4.3. Um gráfico por indivíduo (uma escala por indivíduo)

```
xtline lwage if nr<=100, byopts(rescale)
```

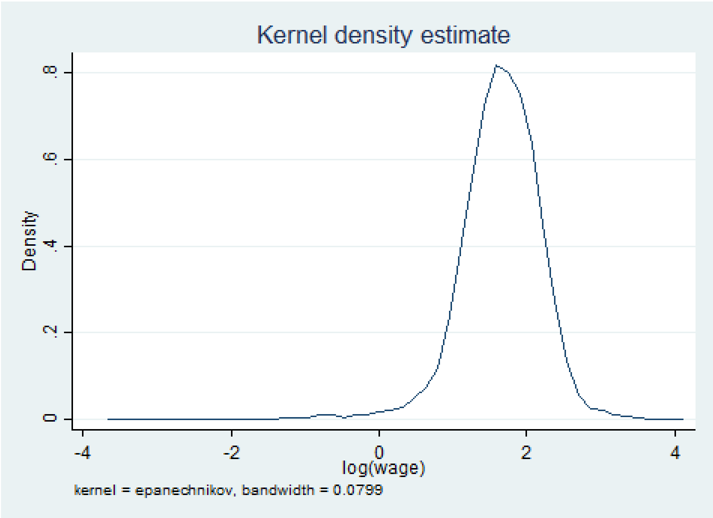
4.4. Histograma

```
histogram lwage
```



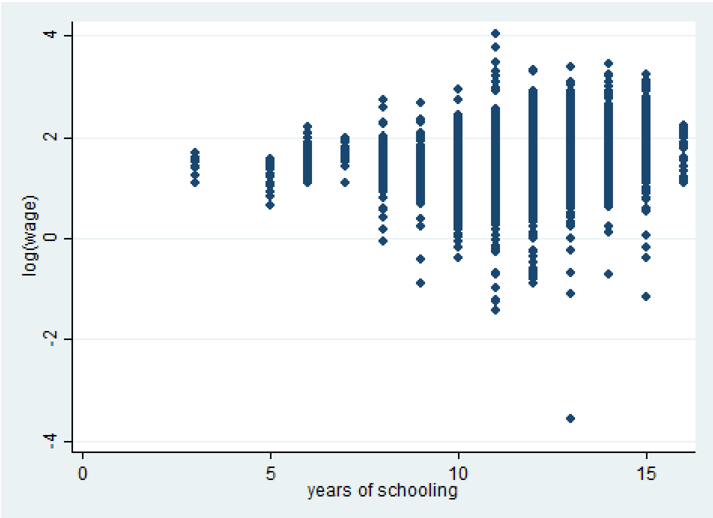
4.5. Distribuição empírica (Kernel)

```
kdensity lwage
```



4.6. Diagrama de dispersão

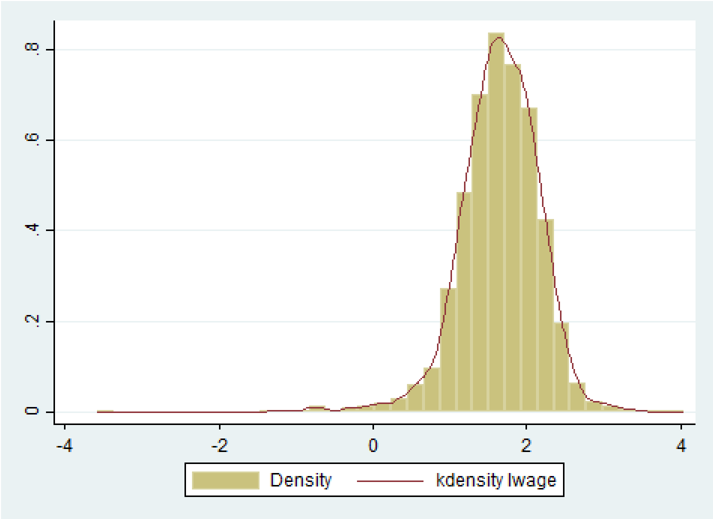
```
scatter lwage educ
```



*4.7. Utilização do comando **`twoway`** (vários diagramas num único output gráfico do Stata)*

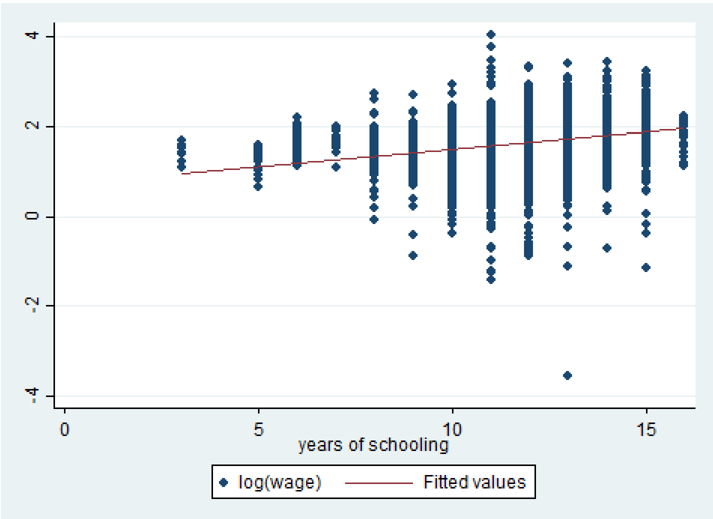
4.7.1. Histograma com densidade empírica

```
twoway (histogram lwage) (kdensity lwage)
```



4.7.2. Diagrama de dispersão com recta de ajustamento

```
twoway (scatter lwage educ) (lfit lwage exper)
```



<u>NOTA</u>: O subcomando **`lfit`** só se encontra disponível dentro do comando **`twoway`**.

5. Regressões e inferência estatística

5.1. Geração de "time dummies" e tendências

5.1.1. "Time dummies"

```
tab year, gen(y)
```

```
   1980 to |
      1987 |      Freq.     Percent        Cum.
-----------+-----------------------------------
      1980 |        545       12.50       12.50
      1981 |        545       12.50       25.00
      1982 |        545       12.50       37.50
      1983 |        545       12.50       50.00
      1984 |        545       12.50       62.50
      1985 |        545       12.50       75.00
      1986 |        545       12.50       87.50
      1987 |        545       12.50      100.00
-----------+-----------------------------------
     Total |      4,360      100.00
```

NOTA: Vão ser geradas variáveis dummy com o prefixo "y" (y1980, y1981, …). A variável y1980 irá assumir o valor 1 para *t*=1980, a variável y1981 irá assumir o valor 1 para *t*=1981 e assim sucessivamente.

5.1.2. Tendência linear

```
bysort nr: gen t=_n
```

5.1.3. Tendência quadrática

```
bysort nr: gen t_sq=t^2
```

5.2. Regressões

5.2.1. "Pooled OLS", com desvios-padrão robustos

<u>Sob as hipóteses clássicas, o erro composto é equiautocorrelacionado por blocos, devido à existência do efeito individual não observado.</u>

```
xi: reg lwage i.year exper expersq educ black hisp married
union, rob cluster(nr)
```

```
i.year            _Iyear_1980-1987    (naturally coded; _Iyear_1980 omitted)

Linear regression                                      Number of obs     =      4,360
                                                       F(14, 544)        =      47.10
                                                       Prob > F          =     0.0000
                                                       R-squared         =     0.1893
                                                       Root MSE          =     .48033

                                   (Std. Err. adjusted for 545 clusters in nr)
------------------------------------------------------------------------------
             |               Robust
       lwage |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 _Iyear_1981 |     .05832    .028228     2.07   0.039     .0028707    .1137693
 _Iyear_1982 |   .0627744   .0369735     1.70   0.090    -.0098538    .1354027
 _Iyear_1983 |   .0620117    .046248     1.34   0.181    -.0288348    .1528583
 _Iyear_1984 |   .0904672    .057988     1.56   0.119    -.0234407     .204375
 _Iyear_1985 |   .1092463   .0668474     1.63   0.103    -.0220644     .240557
 _Iyear_1986 |   .1419596   .0762348     1.86   0.063     -.007791    .2917102
 _Iyear_1987 |   .1738334   .0852056     2.04   0.042     .0064611    .3412057
       exper |   .0672345   .0195958     3.43   0.001     .0287417    .1057273
     expersq |  -.0024117   .0010252    -2.35   0.019    -.0044255   -.0003979
        educ |   .0913498   .0110822     8.24   0.000     .0695807    .1131189
       black |  -.1392342   .0505238    -2.76   0.006    -.2384798   -.0399887
        hisp |   .0160195   .0390781     0.41   0.682     -.060743     .092782
     married |   .1082529    .026034     4.16   0.000     .0571135    .1593924
       union |   .1824613   .0274435     6.65   0.000     .1285531    .2363695
       _cons |   .0920558   .1609365     0.57   0.568    -.2240773    .4081888
------------------------------------------------------------------------------
```

➔ Guardar o *output*:

```
estimates store POLS_Rob
```

➔ Efeito parcial da Educação sobre o Salário de um dado individuo *i* no momento *t*

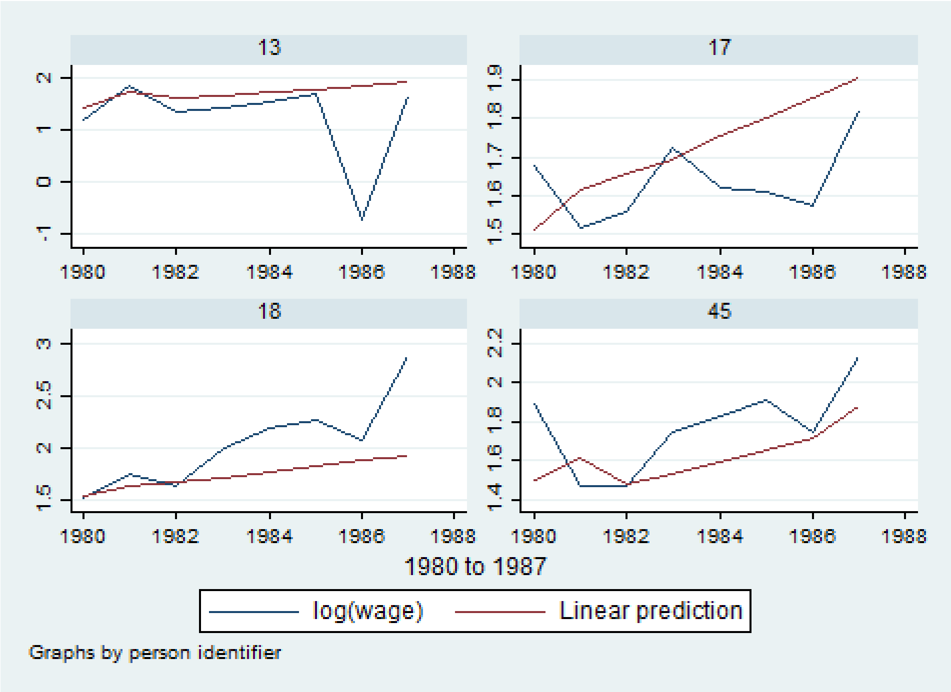
```
display (exp(_b[educ]) - 1)*100
```

```
9.5652184
```

➔ Comando `predict`

```
quiet xi: reg lwage i.year exper expersq educ black hisp
married union, rob cluster(nr)
predict lwage_hat, xb
```

```
xtline lwage lwage_hat if nr<=100, byopts(rescale)
```



5.2.2. “Random effects”

```
xi: xtreg lwage i.year exper expersq educ black hisp married
union, re
i.year            _Iyear_1980-1987    (naturally coded; _Iyear_1980 omitted)

Random-effects GLS regression                   Number of obs     =      4,360
Group variable: nr                              Number of groups  =        545

R-sq:                                           Obs per group:
     within  = 0.1799                                         min =          8
     between = 0.1860                                         avg =        8.0
     overall = 0.1830                                         max =          8

                                                Wald chi2(14)     =     957.77
corr(u_i, X)   = 0 (assumed)                    Prob > chi2       =     0.0000

------------------------------------------------------------------------------
       lwage |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 _Iyear_1981 |    .040462   .0246946     1.64   0.101    -.0079385    .0888626
 _Iyear_1982 |   .0309212   .0323416     0.96   0.339    -.0324672    .0943096
 _Iyear_1983 |   .0202806    .041582     0.49   0.626    -.0612186    .1017798
 _Iyear_1984 |   .0431187   .0513163     0.84   0.401    -.0574595    .1436969
 _Iyear_1985 |   .0578155   .0612323     0.94   0.345    -.0621977    .1778286
 _Iyear_1986 |   .0919476   .0712293     1.29   0.197    -.0476592    .2315544
 _Iyear_1987 |   .1349289   .0813135     1.66   0.097    -.0244427    .2943005
       exper |   .1057545   .0153668     6.88   0.000     .0756361    .1358729
     expersq |  -.0047239   .0006895    -6.85   0.000    -.0060753   -.0033726
        educ |   .0918763   .0106597     8.62   0.000     .0709836    .1127689
       black |  -.1393767   .0477228    -2.92   0.003    -.2329117   -.0458417
        hisp |   .0217317   .0426063     0.51   0.610    -.0617751    .1052385
     married |    .063986   .0167742     3.81   0.000     .0311091    .0968629
       union |   .1061344   .0178539     5.94   0.000     .0711415    .1411273
       _cons |   .0235864   .1506683     0.16   0.876     -.271718    .3188907
-------------+----------------------------------------------------------------
     sigma_u |  .32460315
     sigma_e |  .35099001
         rho |  .46100216   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

➔ Guardar o *output*:

```
estimates store RE_NotRob
```

5.2.3. “Fixed effects”

```
xi: xtreg lwage i.year exper expersq educ black hisp married
union, fe
i.year           _Iyear_1980-1987    (naturally coded; _Iyear_1980 omitted)

Fixed-effects (within) regression               Number of obs      =      4,360
Group variable: nr                              Number of groups   =        545

R-sq:                                           Obs per group:
     within  = 0.1806                                         min =          8
     between = 0.0286                                         avg =        8.0
     overall = 0.0888                                         max =          8

                                                F(10,3805)         =      83.85
corr(u_i, Xb)  = -0.1222                        Prob > F           =     0.0000

------------------------------------------------------------------------------
       lwage |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 _Iyear_1981 |   .1511912   .0219489     6.89   0.000     .1081584     .194224
 _Iyear_1982 |   .2529709   .0244185    10.36   0.000     .2050963    .3008454
 _Iyear_1983 |   .3544437   .0292419    12.12   0.000     .2971125    .4117749
 _Iyear_1984 |   .4901148   .0362266    13.53   0.000     .4190894    .5611402
 _Iyear_1985 |   .6174823   .0452435    13.65   0.000     .5287784    .7061861
 _Iyear_1986 |   .7654966   .0561277    13.64   0.000     .6554532    .8755399
 _Iyear_1987 |   .9250249   .0687731    13.45   0.000     .7901893    1.059861
       exper |          0  (omitted)
     expersq |  -.0051855   .0007044    -7.36   0.000    -.0065666   -.0038044
        educ |          0  (omitted)
       black |          0  (omitted)
        hisp |          0  (omitted)
     married |   .0466804   .0183104     2.55   0.011     .0107811    .0825796
       union |   .0800019   .0193103     4.14   0.000     .0421423    .1178614
       _cons |   1.426019   .0183415    77.75   0.000     1.390058    1.461979
-------------+----------------------------------------------------------------
     sigma_u |  .39176195
     sigma_e |  .35099001
         rho |  .55472817   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(544, 3805) = 9.16                   Prob > F = 0.0000
```

➔ Guardar o *output*:

```
estimates store FE_NotRob
```

NOTA:

A variável `exper` após transformação "*within*" torna-se colinear com a variável `expersq` para alguns indivíduos.

```
foreach x of varlist exper expersq {
     bysort nr: egen `x'_mean_t=mean(`x')
     egen `x'_mean_overall=mean(`x')
     gen `x'_within=`x'-`x'_mean_t
     gen `x'_within_comp=`x'-`x'_mean_t+`x'_mean_overall
}
```

```
tab exper_within
exper_within |      Freq.     Percent        Cum.
-------------+-----------------------------------
        -3.5 |        545       12.50       12.50
        -2.5 |        545       12.50       25.00
        -1.5 |        545       12.50       37.50
         -.5 |        545       12.50       50.00
          .5 |        545       12.50       62.50
         1.5 |        545       12.50       75.00
         2.5 |        545       12.50       87.50
         3.5 |        545       12.50      100.00
-------------+-----------------------------------
       Total |      4,360      100.00
```

```
tab expersq_within
expersq_within |      Freq.     Percent        Cum.
---------------+-----------------------------------
                     (…)
          -9.5 |         55        1.26       49.95
          -8.5 |          2        0.05       50.00
           -.5 |         55        1.26       51.31
            .5 |        211        4.84       56.15
           1.5 |        108        2.48       58.62
           2.5 |         88        2.02       60.64
           3.5 |         47        1.08       61.72
                     (…)
---------------+-----------------------------------
         Total |      4,360      100.00
```

5.3. Testes

5.3.1. Teste à existência de efeitos fixos no tempo (após regressão de Efeitos Fixos)

Válido apenas se não existir heterocedasticidade e autocorrelação no erro composto não transformado

```
xi: testparm i.year
i.year            _Iyear_1980-1987    (naturally coded; _Iyear_1980 omitted)

 ( 1)  _Iyear_1981 = 0
 ( 2)  _Iyear_1982 = 0
 ( 3)  _Iyear_1983 = 0
 ( 4)  _Iyear_1984 = 0
 ( 5)  _Iyear_1985 = 0
 ( 6)  _Iyear_1986 = 0
 ( 7)  _Iyear_1987 = 0

       F(  7,  3805) =   29.24
            Prob > F =    0.0000
```

5.3.2. Teste de Hausman clássico

```
hausman FE_NotRob RE_NotRob
```

```
                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |   FE_NotRob    RE_NotRob      Difference          S.E.
-------------+----------------------------------------------------------------
 _Iyear_1981 |    .1511912      .040462        .1107292               .
 _Iyear_1982 |    .2529709     .0309212        .2220497               .
 _Iyear_1983 |    .3544437     .0202806        .3341631               .
 _Iyear_1984 |    .4901148     .0431187        .4469961               .
 _Iyear_1985 |    .6174823     .0578155        .5596668               .
 _Iyear_1986 |    .7654966     .0919476         .673549               .
 _Iyear_1987 |    .9250249     .1349289         .790096               .
     expersq |   -.0051855    -.0047239       -.0004616        .0001443
     married |    .0466804      .063986       -.0173057        .0073414
       union |    .0800019     .1061344       -.0261326        .0073572
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                 chi2(10) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       26.36
                Prob>chi2 =      0.0033
                (V_b-V_B is not positive definite)
```

NOTA:

Usar as estimativas de Efeitos Fixos em primeiro lugar, uma vez que este é o estimador consistente sob a hipótese de exogeneidade (a hipótese nula) e de endogeneidade (a hipótese alternativa).

5.3.3. Teste de Hausman robusto (via *bootstrap*)

```
rhausman FE_NotRob RE_NotRob, reps(100) cluster
```

```
bootstrap in progress
----+--- 1 ---+--- 2 ---+--- 3 ---+--- 4 ---+--- 5
.................................................. 50
.................................................. 100
------------------------------------------------------------------------------
Cluster-Robust Hausman Test
(based on 100 bootstrap repetitions)

b1: obtained from xtreg lwage _Iyear_* exper expersq educ black hisp married
union, fe
b2: obtained from xtreg lwage _Iyear_* exper expersq educ black hisp married
union, re
Excluded (not identified, or only identified in one model):  exper educ black
hisp

    Test:  Ho:  difference in coefficients not systematic

                 chi2(12) = (b1-b2)' * [V_bootstrapped(b1-b2)]^(-1) * (b1-b2)
                          =      131.34
                Prob>chi2 =      0.0000
```

5.3.4. Procedimento de Chamberlain-Mundlak, como alternativa ao teste de Hausman

i) Construir médias no tempo, para cada indivíduo, das variáveis que variam no tempo:

```
foreach x of varlist exper expersq married union {
   bysort nr: egen mean_`x' = mean(`x')
}
```

ii) Regressão *Pooled OLS* aumentada pelas médias no tempo das variáveis anteriores:

```
xi: reg lwage i.year exper expersq educ black hisp
married union mean_exper mean_expersq mean_married
mean_union, rob cluster(nr)
```

iii) Teste F sobre os coeficientes estimados das médias no tempo das variáveis anteriores:

```
testparm    mean_exper    mean_expersq    mean_married
mean_union
```

```
 ( 1)  mean_exper = 0
 ( 2)  mean_expersq = 0
 ( 3)  mean_married = 0
 ( 4)  mean_union = 0

       F(  4,   544) =    7.79
            Prob > F =    0.0000
```

5.3.5. Teste BP sobre efeitos aleatórios na componente individual (após regressão de Efeitos Aleatórios)

```
quiet xi: xtreg lwage i.year exper expersq educ black hisp
married union, re
xttest0
```

```
Breusch and Pagan Lagrangian multiplier test for random effects

        lwage[nr,t] = Xb + u[nr] + e[nr,t]

        Estimated results:
                         |       Var     sd = sqrt(Var)
                ---------+-----------------------------
                   lwage |   .2836728       .5326094
                       e |    .123194         .35099
                       u |   .1053672       .3246031

        Test:   Var(u) = 0
                             chibar2(01) =  3203.64
                          Prob > chibar2 =   0.0000
```

<u>NOTA:</u>

Este teste consiste num ensaio estatístico sobre a variância da heterogeneidade individual não observada. Concretamente, sob a hipótese nula, testa-se se a variância da heterogeneidade individual não observada é nula.

5.3.6. Testes sobre as componentes do erro (após regressão de Efeitos Aleatórios)

```
quiet xi: xtreg lwage i.year exper expersq educ black hisp
married union, re
xttest1
```

```
Tests for the error component model:

        lwage[nr,t] = Xb + u[nr] + v[nr,t],
       v[nr,t] = lambda v[nr,(t-1)] + e[nr,t]

        Estimated results:
                         |       Var     sd = sqrt(Var)
                ---------+-----------------------------
                   lwage |    .2836728       .5326094
                       e |     .123194      .35099001
                       u |    .1053672      .32460315

        Tests:
           Random Effects, Two Sided:
           ALM(Var(u)=0)         = 1730.12 Pr>chi2(1) =  0.0000

           Random Effects, One Sided:
           ALM(Var(u)=0)         =   41.59 Pr>N(0,1)  =  0.0000

           Serial Correlation:
           ALM(lambda=0)         =  220.40 Pr>chi2(1) =  0.0000

           Joint Test:
           LM(Var(u)=0,lambda=0) = 3424.04 Pr>chi2(2) =  0.0000
```

NOTA:

Este teste generaliza o anterior, testando adicionalmente se o erro idiossincrático é autocorrelacionado de primeira ordem. No *output* é também acrescentado um teste conjunto: sob a hipótese nula a variância da heterogeneidade individual é nula e o erro idiossincrático não é autocorrelacionado de primeira ordem.

5.3.7. Teste de heterocedasticidade (após regressão de Efeitos Fixos)

```
quiet xi: xtreg lwage i.year exper expersq educ black hisp
married union, fe
xttest3
```

```
Modified Wald test for groupwise heteroscedasticity in fixed effect regression
model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (545)  =   2.7e+05
Prob>chi2 =      0.0000
```

5.4. *Revisão dos resultados obtidos*

5.4.1. "Fixed effects" com desvios-padrão robustos

```
xi: xtreg lwage i.year exper expersq educ black hisp married
union, fe rob cluster(nr)
```

```
i.year            _Iyear_1980-1987    (naturally coded; _Iyear_1980 omitted)

Fixed-effects (within) regression               Number of obs      =      4,360
Group variable: nr                              Number of groups   =        545

R-sq:                                           Obs per group:
     within  = 0.1806                                         min =          8
     between = 0.0286                                         avg =        8.0
     overall = 0.0888                                         max =          8

                                                F(10,544)          =      46.59
corr(u_i, Xb)  = -0.1222                        Prob > F           =     0.0000

                              (Std. Err. adjusted for 545 clusters in nr)
------------------------------------------------------------------------------
             |               Robust
       lwage |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 _Iyear_1981 |   .1511912   .0255648     5.91   0.000     .1009733    .2014091
 _Iyear_1982 |   .2529709   .0286624     8.83   0.000     .1966684    .3092733
 _Iyear_1983 |   .3544437   .0348608    10.17   0.000     .2859655     .422922
 _Iyear_1984 |   .4901148   .0454581    10.78   0.000     .4008199    .5794097
 _Iyear_1985 |   .6174823   .0568088    10.87   0.000     .5058908    .7290737
 _Iyear_1986 |   .7654966    .071244    10.74   0.000     .6255495    .9054436
 _Iyear_1987 |   .9250249   .0840563    11.00   0.000     .7599103     1.09014
       exper |          0  (omitted)
     expersq |  -.0051855   .0008102    -6.40   0.000    -.0067771   -.0035939
        educ |          0  (omitted)
       black |          0  (omitted)
        hisp |          0  (omitted)
     married |   .0466804   .0210038     2.22   0.027     .0054218    .0879389
       union |   .0800019   .0227431     3.52   0.000     .0353268    .1246769
       _cons |   1.426019   .0209824    67.96   0.000     1.384802    1.467235
-------------+----------------------------------------------------------------
     sigma_u |  .39176195
     sigma_e |  .35099001
         rho |  .55472817   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

➔ Guardar o *output*:

```
estimates store FE_Rob
```

5.4.2. Teste à existência de efeitos fixos no tempo, versão robusta (apenas após regressão com desvios-padrão robustos)

```
xi: testparm i.year
i.year            _Iyear_1980-1987    (naturally coded; _Iyear_1980 omitted)

 ( 1)  _Iyear_1981 = 0
 ( 2)  _Iyear_1982 = 0
 ( 3)  _Iyear_1983 = 0
 ( 4)  _Iyear_1984 = 0
 ( 5)  _Iyear_1985 = 0
 ( 6)  _Iyear_1986 = 0
 ( 7)  _Iyear_1987 = 0

       F(  7,   544) =   18.07
            Prob > F =    0.0000
```

5.4.3. Estimativas corrigidas (após conclusões retiradas da inferência habitual)

```
estimates table POLS_Rob FE_Rob RE_NotRob, star(.1 .05 .01)
--------------------------------------------------------------
    Variable |   POLS_Rob          FE_Rob         RE_NotRob
-------------+------------------------------------------------
 _Iyear_1981 |  .05831999**      .15119121***       .040462
 _Iyear_1982 |  .06277442*       .25297086***     .03092116
 _Iyear_1983 |  .06201174        .35444374***     .02028064
 _Iyear_1984 |  .09046719        .49011479***     .04311871
 _Iyear_1985 |   .1092463        .61748227***     .05781546
 _Iyear_1986 |  .14195959*       .76549657***     .09194758
 _Iyear_1987 |  .17383343**      .92502493***     .13492892*
       exper |   .0672345***     (omitted)        .10575452***
     expersq |  -.0024117**      -.0051855***    -.00472394***
        educ |  .09134979***     (omitted)        .09187628***
       black | -.13923421***     (omitted)       -.13937673***
        hisp |  .01601951        (omitted)        .02173173
     married |  .10825295***     .04668036**      .06398602***
       union |  .18246128***     .08000186***     .10613443***
       _cons |  .09205578        1.4260185***     .02358638
--------------------------------------------------------------
                           legend: * p<.1; ** p<.05; *** p<.01
```

5.5. *Outras regressões de interesse*

5.5.1. Máxima verosimilhança (equivalente à regressão de Efeitos Aleatórios)

xi: xtreg lwage i.year exper expersq educ black hisp married union, mle

```
i.year           _Iyear_1980-1987    (naturally coded; _Iyear_1980 omitted)

Fitting constant-only model:
Iteration 0:   log likelihood = -2621.1726
Iteration 1:   log likelihood = -2621.1724

Fitting full model:
Iteration 0:   log likelihood = -2204.5828
Iteration 1:   log likelihood = -2187.0507
Iteration 2:   log likelihood = -2186.9587
Iteration 3:   log likelihood = -2186.9587

Random-effects ML regression                    Number of obs     =      4,360
Group variable: nr                              Number of groups  =        545

Random effects u_i ~ Gaussian                   Obs per group:
                                                              min =          8
                                                              avg =        8.0
                                                              max =          8

                                                LR chi2(14)       =     868.43
Log likelihood  = -2186.9587                    Prob > chi2       =     0.0000

------------------------------------------------------------------------------
       lwage |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 _Iyear_1981 |   .0403672   .0246825     1.64   0.102    -.0080096    .0887439
 _Iyear_1982 |   .0307495   .0324581     0.95   0.343    -.0328673    .0943662
 _Iyear_1983 |   .0200545   .0418377     0.48   0.632    -.0619459    .1020549
 _Iyear_1984 |   .0428593    .051713     0.83   0.407    -.0584963    .1442149
 _Iyear_1985 |   .0575217   .0617709     0.93   0.352     -.063547    .1785905
 _Iyear_1986 |   .0916527   .0719097     1.27   0.202    -.0492877    .2325932
 _Iyear_1987 |   .1347024   .0821346     1.64   0.101    -.0262784    .2956832
       exper |   .1059824   .0154449     6.86   0.000     .0757109     .136254
```

```
     expersq |  -.0047369   .0006881    -6.88   0.000    -.0060855   -.0033883
        educ |   .0918869     .01078     8.52   0.000     .0707585    .1130153
       black |  -.1393818   .0482582    -2.89   0.004    -.2339662   -.0447974
        hisp |   .0217738   .0430892     0.51   0.613    -.0626795    .1062271
     married |   .0635649   .0167793     3.79   0.000     .0306782    .0964517
       union |   .1054796   .0178849     5.90   0.000     .0704258    .1405334
       _cons |   .0231639   .1523257     0.15   0.879     -.275389    .3217168
-------------+----------------------------------------------------------------
    /sigma_u |   .3298715   .0114704                      .3081389    .3531369
    /sigma_e |   .3506647   .0040172                       .342879    .3586273
         rho |   .4694743   .0185065                      .4333786    .5058228
------------------------------------------------------------------------------
LR test of sigma_u=0: chibar2(01) = 1590.05            Prob >= chibar2 = 0.000
```

➔ Guardar o *output*:

estimates store MLE_NotRob

5.5.2. "Random effects" com erros idiossincráticos a seguir um processo AR(1)

```
xi: xtregar lwage i.year exper expersq educ black hisp
married union, re rhotype(regress)
```

```
i.year            _Iyear_1980-1987    (naturally coded; _Iyear_1980 omitted)

RE GLS regression with AR(1) disturbances       Number of obs      =      4,360
Group variable: nr                              Number of groups   =        545

R-sq:                                           Obs per group:
     within  = 0.1800                                         min =          8
     between = 0.1857                                         avg =        8.0
     overall = 0.1828                                         max =          8

                                                Wald chi2(15)      =     917.48
corr(u_i, Xb)      = 0 (assumed)                Prob > chi2        =     0.0000

------------------------------------------------------------------------------
       lwage |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 _Iyear_1981 |   .0403896   .0242942     1.66   0.096    -.0072261    .0880053
 _Iyear_1982 |   .0307824   .0323377     0.95   0.341    -.0325983    .0941632
 _Iyear_1983 |   .0200269    .041557     0.48   0.630    -.0614233    .1014771
 _Iyear_1984 |   .0427695   .0512325     0.83   0.404    -.0576443    .1431833
 _Iyear_1985 |   .0572992   .0610717     0.94   0.348    -.0623992    .1769976
 _Iyear_1986 |   .0912774   .0709813     1.29   0.198    -.0478434    .2303982
 _Iyear_1987 |   .1342057    .080975     1.66   0.097    -.0245024    .2929137
       exper |   .1057647   .0155199     6.81   0.000     .0753462    .1361832
     expersq |  -.0047171   .0007078    -6.66   0.000    -.0061044   -.0033298
        educ |   .0919214   .0106064     8.67   0.000     .0711332    .1127096
       black |  -.1391669   .0474855    -2.93   0.003    -.2322369   -.046097
        hisp |   .0218883   .0423899     0.52   0.606    -.0611944    .1049711
     married |   .0640884   .0169529     3.78   0.000     .0308613    .0973155
       union |   .1043425   .0178666     5.84   0.000     .0693245    .1393605
       _cons |   .0233262   .1499736     0.16   0.876    -.2706167    .3172691
-------------+----------------------------------------------------------------
      rho_ar |  .04499333   (estimated autocorrelation coefficient)
     sigma_u |  .32222559
     sigma_e |  .35241063
     rho_fov |  .45534671   (fraction of variance due to u_i)
       theta |  .62658942
------------------------------------------------------------------------------
```

➔ Guardar o *output*:

```
estimates store RE_NotRob_AR1
```

5.5.3. "Fixed effects" com erros idiossincráticos a seguir um processo AR(1)

```
xi: xtregar lwage i.year exper expersq educ black hisp
married union, fe rhotype(regress)
```

```
i.year            _Iyear_1980-1987    (naturally coded; _Iyear_1980 omitted)

FE (within) regression with AR(1) disturbances  Number of obs     =     3,815
Group variable: nr                              Number of groups  =       545

R-sq:                                           Obs per group:
     within  = 0.1320                                         min =         7
     between = 0.0371                                         avg =       7.0
     overall = 0.0736                                         max =         7

                                                F(9,3261)         =     55.12
corr(u_i, Xb)  = -0.0843                        Prob > F          =    0.0000

------------------------------------------------------------------------------
       lwage |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 _Iyear_1981 |  -.6646625     .070515    -9.43   0.000    -.8029207   -.5264044
 _Iyear_1982 |  -.6070855    .0663866    -9.14   0.000    -.7372492   -.4769217
 _Iyear_1983 |  -.5170418    .0575465    -8.98   0.000    -.6298727    -.404211
 _Iyear_1984 |  -.3924154     .047332    -8.29   0.000    -.4852189    -.299612
 _Iyear_1985 |  -.2779792    .0361975    -7.68   0.000    -.3489513    -.207007
 _Iyear_1986 |  -.1443115    .0250877    -5.75   0.000    -.1935007   -.0951223
 _Iyear_1987 |          0  (omitted)
       exper |          0  (omitted)
     expersq |  -.0043665    .0008372    -5.22   0.000    -.0060081    -.002725
        educ |          0  (omitted)
       black |          0  (omitted)
        hisp |          0  (omitted)
     married |   .0535985     .019342     2.77   0.006     .0156748    .0915223
       union |   .0676536    .0203133     3.33   0.001     .0278255    .1074816
       _cons |   2.265653    .0853663    26.54   0.000     2.098276    2.433031
-------------+----------------------------------------------------------------
      rho_ar |  .04499333
     sigma_u |  .39940229
     sigma_e |  .32531058
     rho_fov |  .60117842   (fraction of variance because of u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(544,3261) = 9.15                    Prob > F = 0.0000
```

➔ Guardar o *output*:

```
estimates store FE_NotRob_AR1
```

5.5.4. "Pooled OLS" com desvios-padrão robustos à presença de heterocedasticidade e autocorrelação de primeira ordem

```
xi: xtscc lwage i.year exper expersq educ black hisp married union, lag(1)
```

```
i.year           _Iyear_1980-1987    (naturally coded; _Iyear_1980 omitted)

Regression with Driscoll-Kraay standard errors   Number of obs      =      4360
Method: Pooled OLS                               Number of groups   =       545
Group variable (i): nr                           F( 14,      7)     =  95799.91
maximum lag: 1                                   Prob > F           =    0.0000
                                                 R-squared          =    0.1893
                                                 Root MSE           =    0.4803

------------------------------------------------------------------------------
             |             Drisc/Kraay
       lwage |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 _Iyear_1981 |     .05832   .0153055     3.81   0.007     .0221283    .0945117
 _Iyear_1982 |   .0627744   .0285012     2.20   0.063    -.0046202    .1301691
 _Iyear_1983 |   .0620117   .0395559     1.57   0.161    -.0315231    .1555465
 _Iyear_1984 |   .0904672   .0486179     1.86   0.105     -.024496    .2054304
 _Iyear_1985 |   .1092463   .0553422     1.97   0.089    -.0216173    .2401099
 _Iyear_1986 |   .1419596   .0602779     2.36   0.051     -.000575    .2844942
 _Iyear_1987 |   .1738334   .0641219     2.71   0.030     .0222091    .3254577
       exper |   .0672345    .022417     3.00   0.020     .0142267    .1202423
     expersq |  -.0024117   .0010931    -2.21   0.063    -.0049965    .0001731
        educ |   .0913498   .0025271    36.15   0.000     .0853741    .0973254
       black |  -.1392342   .0166139    -8.38   0.000    -.1785198   -.0999486
        hisp |   .0160195    .007817     2.05   0.080    -.0024647    .0345037
     married |   .1082529   .0058966    18.36   0.000     .0943098    .1221961
       union |   .1824613   .0173384    10.52   0.000     .1414624    .2234601
       _cons |   .0920558   .0837923     1.10   0.308    -.1060815     .290193
------------------------------------------------------------------------------
```

➔ Guardar o *output*:

```
estimates store POLS_DKRob_AR1
```

5.5.5. “Fixed effects” com desvios-padrão robustos à presença de heterocedasticidade e autocorrelação de primeira ordem

```
xi: xtscc lwage i.year exper expersq educ black hisp married
union, fe lag(1)
```

```
i.year            _Iyear_1980-1987    (naturally coded; _Iyear_1980 omitted)

Regression with Driscoll-Kraay standard errors   Number of obs     =      4360
Method: Fixed-effects regression                 Number of groups  =       545
Group variable (i): nr                           F( 14,      7)    =    335.73
maximum lag: 1                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.1806

------------------------------------------------------------------------------
             |             Drisc/Kraay
       lwage |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 _Iyear_1981 |   .0190448    .0027545     6.91   0.000     .0125315    .0255581
 _Iyear_1982 |   -.011322    .0047246    -2.40   0.048    -.0224939   -.0001501
 _Iyear_1983 |  -.0419955    .0055085    -7.62   0.000     -.055021   -.0289701
 _Iyear_1984 |  -.0384709    .0055679    -6.91   0.000    -.0516368   -.0253049
 _Iyear_1985 |  -.0432498    .0045205    -9.57   0.000    -.0539391   -.0325606
 _Iyear_1986 |  -.0273819    .0026252   -10.43   0.000    -.0335896   -.0211743
 _Iyear_1987 |          0  (omitted)
       exper |   .1321464    .0068163    19.39   0.000     .1160284    .1482645
     expersq |  -.0051855    .0004963   -10.45   0.000    -.0063591   -.0040119
        educ |   .0873325    .0012897    67.72   0.000     .0842829    .0903822
       black |          0  (omitted)
        hisp |          0  (omitted)
     married |   .0466804    .0103302     4.52   0.003     .0222534    .0711073
       union |   .0800019    .0118711     6.74   0.000     .0519311    .1080726
       _cons |          0  (omitted)
------------------------------------------------------------------------------
```

➔ Guardar o *output*:

```
estimates store FE_DKRob_AR1
```

Bibliografia:

Baltagi, B. (2013), *Econometric Analysis of Panel Data*, 5th edition, Wiley

Wooldridge, J. (2010), *Econometric Analysis of Cross Section and Panel Data*, 2nd edition, MIT Press